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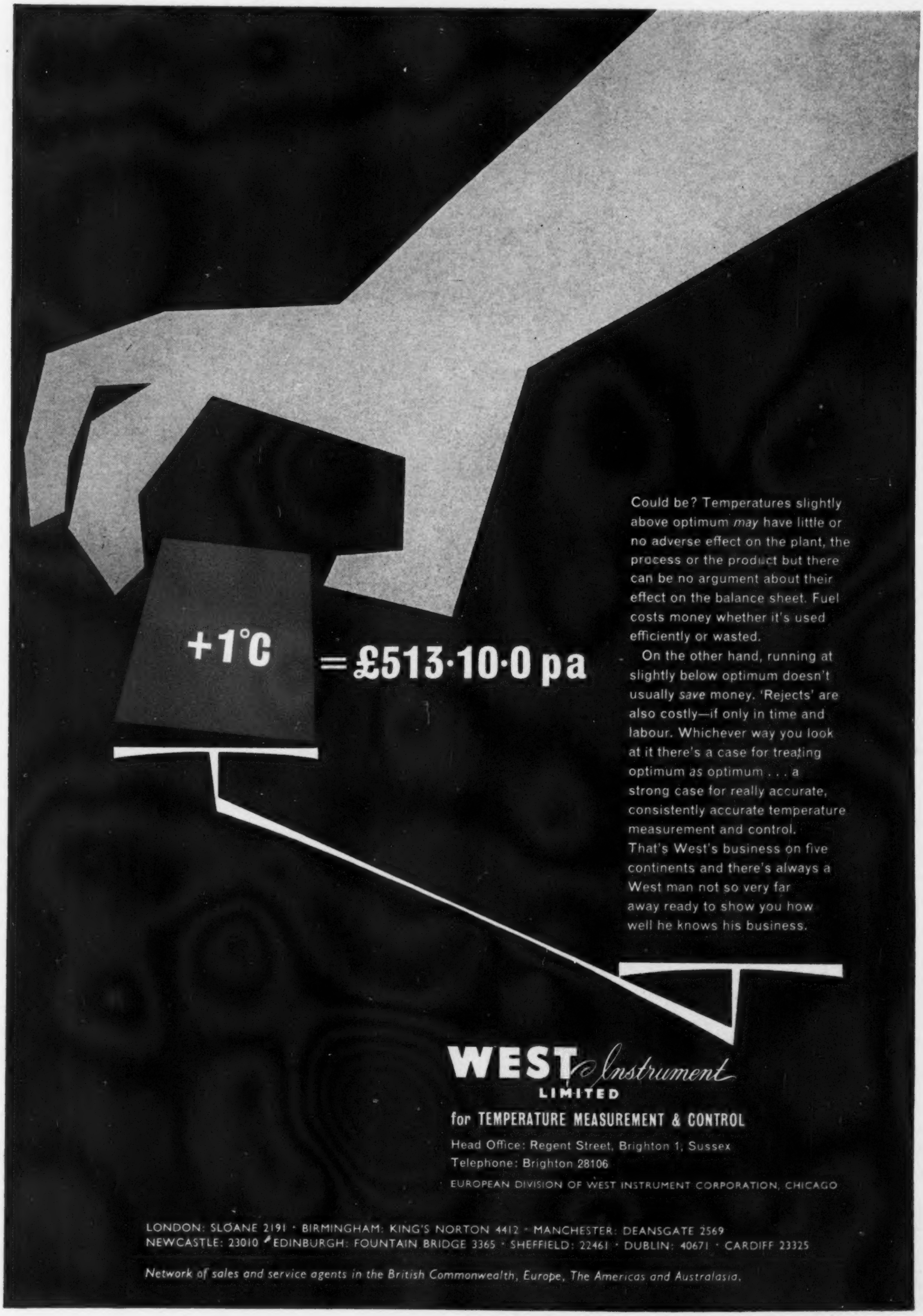

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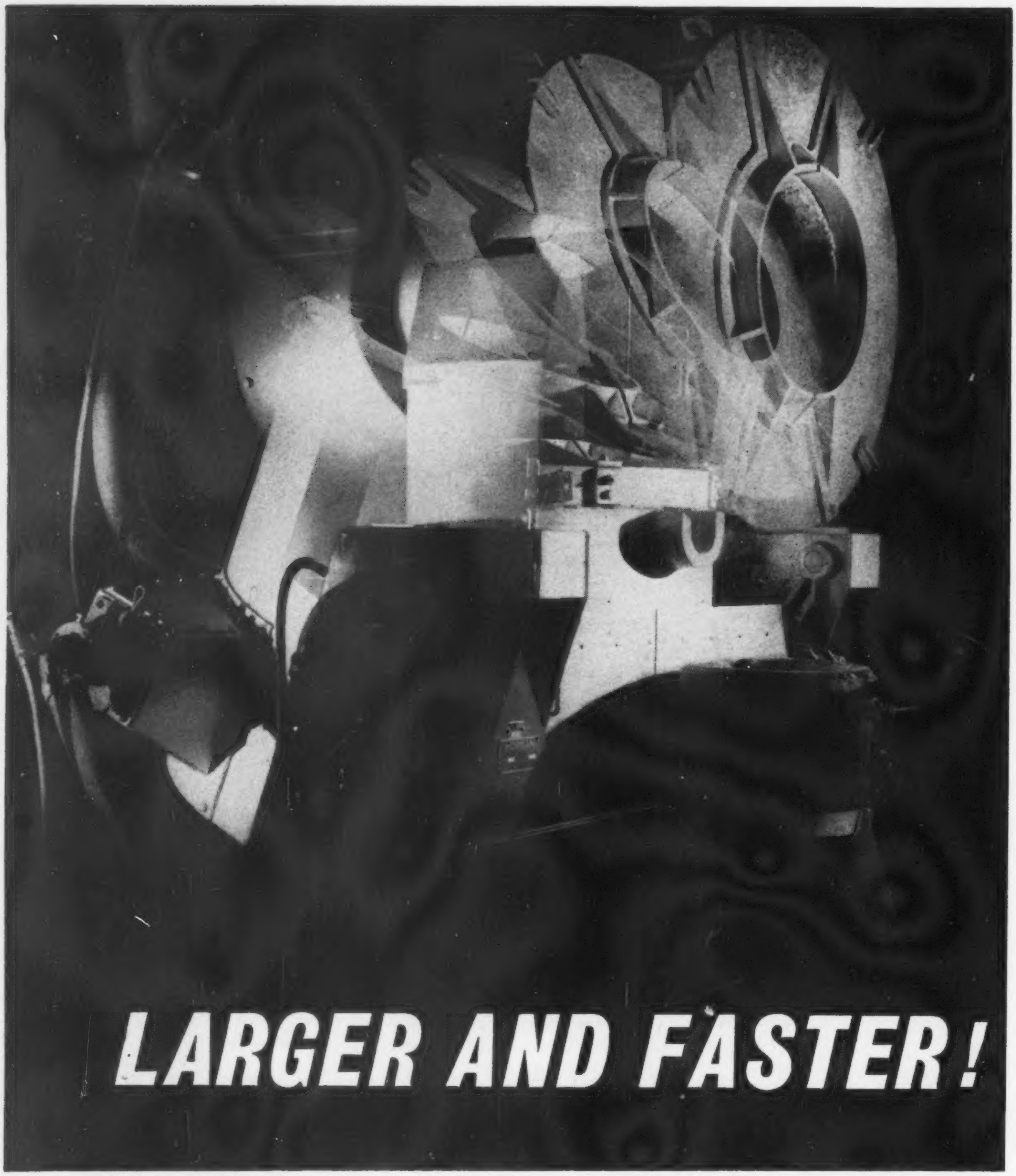

LARGER AND FASTER!

Electrical Aids in Industry *Data Sheet* **No. 16**

Speed control of Electric Motors

'Variable' speed may involve two or three (or more) speed steps or infinitely variable (stepless) speed control. It is this latter type which is considered below. Of the many advantages of electric drives, the opportunity offered for infinitely variable speed control is outstanding. Unfortunately this advantage is not used as much as it might be to increase the speed of working, and to improve productivity and quality.

Principal Factors Affecting Choice of Drive

(a) First cost, (b) Efficiency, (c) Speed range, (d) Regulation, (e) Power-to-weight ratio, (f) Availability of supply, (g) Maintenance and reliability, (h) Change in power and torque over the speed range, (i) Simplicity of control gear, (j) Effect of variation in supply, (k) Power factor, (l) Characteristics of the load, (m) Operational environment, (n) Braking requirements.

This list is not meant to be all-embracing, for there well may be factors not mentioned which could prove conclusive in the choice of a drive.

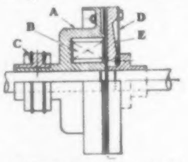
The following are some methods of obtaining infinitely variable speeds:

Alternating Current Motors

The vast majority of electric drives in use today employ A.C. motors. Although not quite so flexible as D.C. motors in the matter of speed control, there are available many types which give a large measure of speed variation.

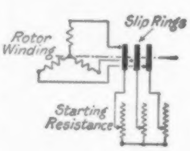
INDUCTION MOTORS. Although the squirrel-cage motor is essentially a constant-speed machine, it is much used for stepless variable speed drives with one of the following types:

(a) Eddy-current coupling,
(b) Ferro-magnetic particle coupling,
(c) Mechanical drives, e.g. belt drives and friction drives,
(d) Hydraulic variable speed drives.



A, Magnet body; B, Magnet coil; C, Collector gear; D, Spring plate; E, Armature.

SLIP-RING MOTOR. The slip-ring motor, which costs more than the squirrel-cage motor, can be varied in speed by means of the resistors in the rotor circuit used for starting. The amount of resistance in circuit can be varied in steps by means of different forms of control gear operated by hand, push-button or automatically controlled contactors.



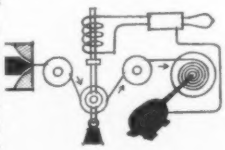
A.C. COMMUTATOR MOTORS. These are three-phase induction motors provided with additional windings which, through a commutator and brushes, permit speed adjustment in either direction below and above synchronous speed. The brush gear can be automatically controlled so as to vary the speed according to a known programme or cycle of operation such as in spinning frames. The Schrage and similar motors are refinements of this type.

Ward-Leonard System

In this system the armature of a D.C. motor is supplied at variable voltage from a separate generator. The generator may be driven by an A.C. or D.C. motor directly coupled to it and to an exciter which supplies the field windings of the generator and main motor. By means of a potentiometer resistance, with mid-point connected to one terminal of the generator field windings, the generator voltage may be varied from maximum to zero.

Electronic Motor Control

Motor speeds can be controlled accurately by electronic methods. Such drives can respond in any desired manner to variations in one or more variables and several drives can be interlocked so that their speeds are always in the same ratio. A typical application is on several separate conveyors. The system can be speeded up or slowed down from a ' master ' controller, but for ' running in ' purposes the speed of each drive can be individually regulated. Electronic speed control has been successfully applied where human control is not possible, e.g. in register control. In this example print must always be placed at exact positions on packaging material. The sketch shows electronic control of wire tension in drawing operations.



Direct Current Motors

While it is unlikely that a mains supply of D.C. will be available, the striking advantages of D.C. motors sometimes make it worth while installing a rectifier, e.g. a motor-generator set, a mercury-arc or a semi-conductor. The speed of D.C. motors is easily controlled by inserting a resistance in series with the motor. Although this can result in a certain amount of wasted electricity, the benefits derived will often heavily outweigh such losses.

For further information get in touch with your Electricity Board or write direct to the Electrical Development Association, 2 Savoy Hill, London, W.C.2. Telephone: TEMple Bar 9434.

Excellent reference books on electricity and productivity (8/6 each, or 9/- post free) are available —' Electric Motors and Controls ' is an example.

E.D.A. also have available on free loan in the United Kingdom a series of films on the industrial uses of electricity. Ask for a catalogue.

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METAL INDUSTRY

VOLUME 98 NUMBER 8 24 FEBRUARY 1961

Lead and Zinc Outlook

THE sharp rise in the price of lead and zinc on the London Metal Exchange during the past few weeks suggests along what lines dealers are thinking regarding the outcome of the Lead and Zinc Study Group meeting which is to be held in Mexico City next month. In commenting upon this, the metal correspondent of *Comtelburo* says that, statistically, lead is the weaker of the two metals, and calls for a greater degree of curtailment of actual production if world supply and demand are to be brought into closer alignment. In the past, producers have been withholding supplies from the market, with the result that world stocks have risen. At the end of last year they stood at 381,276 short tons, according to the American Bureau of Metal Statistics, a rise of around 88,500 tons from the end-1959 total. A combined lead and zinc price of about £160 per ton is said to be economic to producers of the two metals. At present they add up to about £150 per ton; recently the combined total was about £144.

A pointer towards what may result from next month's meeting was the Consolidated Mining and Smelting Company of Canada's 20 per cent cutback in its mine production of lead for 1961, announced last month. In terms of refined metal it means a reduction of around 28,000 tons. Although no further cutbacks have been reported, the feeling appears widespread that the Canadian company would not have taken this step without some understanding from other producers that they would be prepared to trim their outputs, too. In fact, it would not be unreasonable to assume that a certain amount of preparatory work has been going on behind the scenes, and that some measure of agreement has already been reached. There has also been some talk of renewed United States barter deals, although that country would possibly want guarantees of actual cutbacks before entering into such transactions, which might well involve absorbing some of the existing stocks of the metal.

As for zinc, generally speaking this metal is still statistically sound, despite the removal of restrictions on market supplies agreed to at the Study Group meeting twelve months ago. It would seem that the U.S.A. is the weak link in the chain. Consumption in that country last year declined, but in the rest of the world it increased. Free World stocks of the metal at the end of 1960 stood at 302,185 short tons, of which nearly two-thirds was held in the United States. Perhaps it was not surprising, therefore, that production cutbacks have recently been announced in that country. One U.S. company plans to cut its production of metallic zinc for the first half of 1961 by 10 per cent, while another company has introduced an immediate cutback of its refined zinc production by 15 per cent.

Finally, the rise in both metals has doubtless been assisted to some extent by the disturbed situation in Central Africa, where useful tonnages are produced. The Congo Republic, in 1959, for instance, produced about 54,000 tons of slab zinc, while Northern Rhodesia in 1960 produced about 30,000 tons of slab zinc and about 14,500 tons of refined lead. Exchange prices are currently stable.

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Out of the MELTING POT

Wider Scope

ALTHOUGH electroplating and electroforming appeared on the scene at about the same time, the interest shown in the latter has always been very much smaller and its development correspondingly slower. This attitude to electroforming has, until recently, been matched by the limited range of materials considered in connection with the process. This limited range of materials also reflects the lopsided development of electrodeposition in general, a development which, for various reasons, is concerned much more with plating conditions, and above all plating-solution compositions, than with the nature of the materials deposited, a concern which has resulted in innumerable patents covering solutions and additives, all intended to produce bright deposits of three or four metals. This situation is analogous to one in which there would have been developed a hundred or so different methods of melting and casting aluminium and just two or three undeveloped and undistinguished aluminium alloy compositions. There have been a few signs that this situation can be, and let us hope is going to be, remedied. Where electroplating or the lack of its development set limits to the composition of the deposits, it has now been suggested that additional constituents should be introduced by other means. Thus, wear resistant coatings or electroformed parts, such as gauge elements, can be formed by combining the deposition of a suitable metal with the settling out on the surface from suspension in the plating bath of particles of hard wear-resisting materials (alumina, silica, silicon carbide, tungsten carbide, diamond), a suitable proportion of these particles becoming incorporated in the electrodeposited metal. Essentially, the same procedure has been proposed for the production of bearing surfaces, the non-electrolytically deposited particles in this case being those of a solid lubricant such as graphite or molybdenum disulphide.

No Answer

ON occasions, too much information can be a distinct embarrassment, especially if provided in reply to a simple question. In some cases, of course, a simple question may not admit of a simple answer. Ideally, the information provided should then make it clear what questions it is in fact meant to answer. Unfortunately, more often than not, this is left unspecified: the search for information starts from the original simple question only to forget about it almost at once and then to lose itself in a mass of details which, even when added together, do not constitute an answer. Worse still, the results may, as it were, turn round to question the original question, e.g.: "Ductility? It all depends on what you mean by ductility". The ductility or otherwise of chromium is a typical case in point. In spite of a vast amount of research, the answer to such a simple question as "Is chromium ever ductile?" is still likely to be: "It depends on what you mean by ductile"; or possibly even: "It depends on what you mean by chromium". If, undeterred, one examines some of the experimental work, the reason for these "answers" soon becomes apparent. There is, in fact, a considerable difference between chromium prepared by one method and chromium prepared by another method, or even chromium prepared by the same method by somebody else, not to mention the further differences introduced by subsequent mechanical and heat-treatments and the different methods of evaluating ductility, if any. The different theories that have been advanced to explain all these differences will be found to add to the confusion. All this may eventually suggest that the answer to the original simple question is being looked for, for the time being at any rate, in the wrong place. Turning elsewhere, and noting the recent successful fabrication of so many "brittle" or at least awkward metals and alloys, and noting the absence from among them of chromium, the simple answer to be arrived at would appear to be that, for the present, chromium, for simple practical purposes, is not ductile.

Inexplicable Voids

FORMATION of voids in creep specimens at elevated temperature has been a well-known phenomenon for some time, the voids being regarded as the results of vacancy condensation, the test conditions being favourable to vacancy mobility. The more recently reported formation of voids in ductile fracture of test specimens at room temperature is more difficult to explain. Indeed, some observations on the phenomenon in a cobalt-iron alloy (49 per cent cobalt, 49 per cent iron, 2 per cent vanadium) give rise to more questions than answers regarding the growth mechanism of the voids. The above alloy, in a suitably quenched condition, exhibits high ductility (43-81 per cent reduction in area at fracture) with typical cup-and-cone formation. No voids are formed when the same alloy is tested in the brittle state. In the ductile alloy, voids having a maximum cross-sectional area of 6×10^{-4} cm^2 were observed, this size being about an order of magnitude larger than that of the intercrystalline voids produced under creep conditions in copper and alpha-brass. Micro-structure did not appear to impose any constraint on the formation of the voids. Although voids often formed in the central column of the neck and near the fracture surface (which would conform to the theory that their formation is due to hydrostatic tension), voids also formed in surface layers (where hydrostatic tension is not appreciable) and near the shoulders of the specimen (where hydrostatic tension does not develop). The fact that plastic deformation is required, suggests that voids may be initiated by the piling up of dislocations against inclusions. But this leaves unexplained the mechanism of their subsequent growth, in which hydrostatic tension does not operate and growth by vacancy condensation must be ruled out because of the limited diffusion of the vacancies at the test temperature and the limited time available. The contribution made by voids to the process of fracture is likewise indefinite. Thus, whereas voids often constitute a small portion of the fracture surface, the joining of voids to produce large cracks is not common. Initiation of fine cracks from the voids was not observed. On the contrary, the propagation of a crack may be halted, at least momentarily, when the tip of the crack runs into a void, which then acts to reduce the stress concentration at the tip of the crack (cf. the practice of stopping an incipient fatigue crack by drilling out its end).

Skimmer

INFLUENCE OF DIFFERENT METHODS FOR MAKING ADDITIONS OF PHOSPHORUS

Hyper-Eutectic Aluminium-Silicon Casting Alloys

By S. J. ASHTON, M.Eng., A.I.M., J. MUIR, L.I.M. and W. M. DOYLE, Ph.D., M.Eng., F.I.M.

(*Research Division, High Duty Alloys Ltd., Slough*)

(*Continued from* METAL INDUSTRY, 17 *February* 1961

THE tensile properties of the sand-cast and die-cast bars from the various melts were determined, and the results are given in Table VII, the values being the mean of at least triplicate tests. It will be seen that the strength of the die-cast bars was considerably superior to that of the sand-cast series, but the percentage elongations were similar.

Considering the results for the melts nucleated with EP1136, the level of strength in the die-cast bars increased in general, with total phosphorus contents up to 0·0161 per cent, but a slight decrease occurred with 0·0173 per cent phosphorus. Little difference was observed in the strength of the sand-cast bars with total phosphorus contents between 0·0099 per cent and 0·0173 per cent. The percentage elongation values were within the expected range, and no significant variations were obtained. The highest levels of tensile strength for the die- and sand-cast test bars treated with Nucleant 10 were attained with total phosphorus contents of 0·0146 per cent and 0·0618 per cent respectively, and the best combination of strength and percentage elongation in the "ferro-phosphorus" series was produced with a total phosphorus content of 0·0119 per cent.

For ease of comparison, the levels of mean ultimate tensile strength in the die-cast bars have been plotted against the total phosphorus contents for the three refining agents, the curves being shown in Fig. 1. It appears that the method of adding the phosphorus to the melts has little effect on the tensile strength and that, in general, once 0·010-0·015 per cent total phosphorus has been introduced, no further increase in strength is obtained.

Metallographic Examination

Examination of the microstructures of the disc castings revealed that, in the case of those produced from the melts refined with EP1136, as the total phosphorus content increased to 0·0161 per cent the primary silicon crystals became progressively smaller in size, to about 0·03 mm., and the structure more regular. The maximum refinement obtained with Nucleant 10 was produced with a total phosphorus content of 0·0295 per cent, which gave an average primary silicon crystal size of 0·03 mm. However, with a total phosphorus content of 0·0618 per cent, the primary silicon size increased slightly to 0·04 mm.

The microstructures of the 1 in. diameter die-cast sections from the

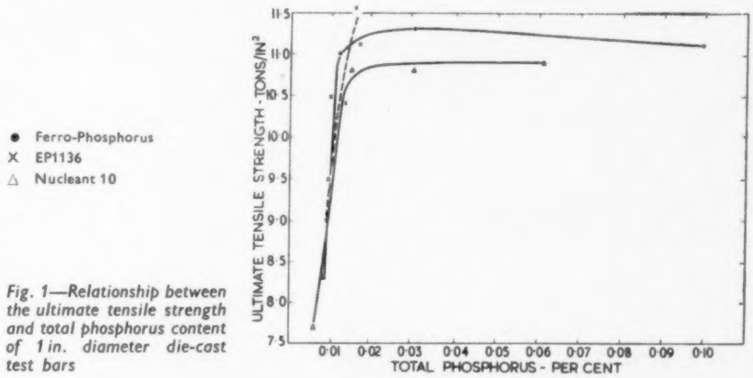


Fig. 1—Relationship between the ultimate tensile strength and total phosphorus content of 1 in. diameter die-cast test bars

TABLE VII—MEAN TENSILE PROPERTIES OF SAND-CAST AND DIE-CAST TEST BARS REFINED WITH THE VARIOUS NUCLEANTS

Total Phosphorus Content in Test Bars (per cent)	Type of Test Bar (1 in. diameter) (as-cast)	0·1 per cent Proof Stress tons/in²	U.T.S. tons/in²	Elongation per cent on $4\sqrt{A}$
Refined with EP1136				
0·0089	die	8·4	9·0	0·5
	sand	5·6	6·6	0·2
0·0099	die	8·0	10·5	0·35
	sand	6·2	7·3	0·3
0·0131	die	8·2	10·4	0·6
	sand	6·5	7·4	0·55
0·0161	die	8·8	11·6	0·35
	sand	6·4	7·3	0·35
0·0173	die	9·9	11·1	0·35
	sand	6·6	7·3	0·4
Refined with Nucleant 10				
0·0053	die	6·8	7·7	0·3
	sand	4·4	4·8	0·15
0·0105	die	8·2	9·6	0·4
	sand	5·3	5·7	0·3
0·0146	die	8·3	10·8	0·5
	sand	6·4	7·1	0·25
0·0295	die	7·8	10·8	0·25
	sand	6·3	6·9	0·2
0·0618	die	8·4	10·9	0·3
	sand	6·7	7·7	0·2
Refined with Ferro-Phosphorus				
0·0083	die	7·4	8·3	0·75
	sand	3·9	4·6	1·0
0·0124	die	7·8	11·0	0·7
	sand	7·0	7·7	0·8
0·0301	die	7·8	11·3	0·3
	sand	6·8	7·1	0·4
0·1015	die	8·3	11·1	0·25
	sand	6·5	7·0	0·4

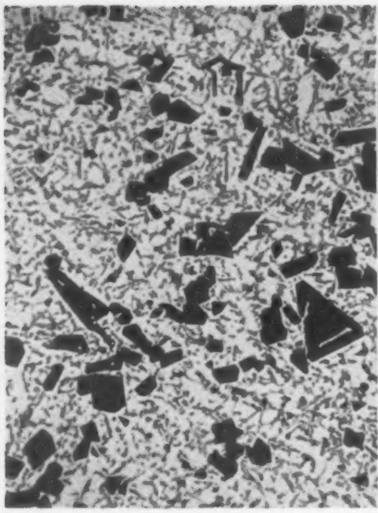


Fig. 2—1 in. diameter die-cast bar. Total phosphorus content of 0·0089 per cent introduced by EP1136 (× 100)

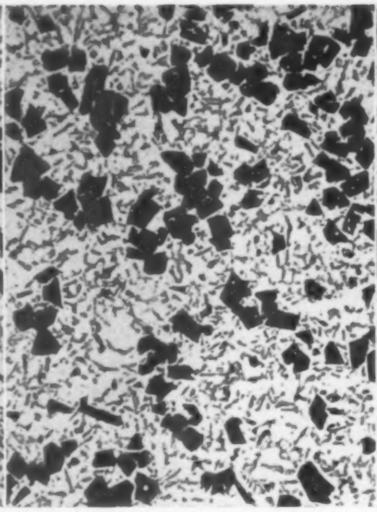


Fig. 3—1 in. diameter die-cast bar. Total phosphorus content of 0·0131 per cent introduced by EP1136 (× 100)

Fig. 4—1 in. diameter die-cast bar. No phosphorus addition (× 100)

EP1136 series showed that as the total phosphorus content was increased to 0·0131 per cent, the primary silicon crystals became finer and more regular (Figs. 2 and 3) and were within the range 0·02-0·06 mm. For comparison purposes, a typical microstructure of a 1 in. diameter die-cast bar produced from a non-refined melt of EX.451 is shown in Fig. 4. The most satisfactory structures in the die-cast test bars refined with Nucleant 10 were obtained with total phosphorus contents of 0·0146 per cent and 0·029 per cent, which gave primary silicon particles of 0·03-0·04 mm. (Fig. 5). Decreasing or increasing the phosphorus content resulted in coarser and more irregular structures.

After the refinement with ferro-phosphorus, very satisfactory similar structures were obtained in the $\frac{1}{8}$ in., $\frac{1}{2}$ in. and 1 in. thick die-cast sections with all the total phosphorus contents investigated. In each case, the primary silicon crystals were regular, well nucleated and within the size range 0·02-0·04 mm. (see Figs. 6 and 7). It was considered that the ferro-phosphorus tablets produced a higher degree of refinement than the other two nucleants.

Microscopic examination of the structures of the 1 in. diameter sand-cast test bars from the melts refined with the various nucleating agents, showed that once a certain level of phosphorus was introduced, no further benefit in refinement was obtained. This minimum total phosphorus content was 0·0099, 0·0146 and 0·0083 per cent for EP1136, Nucleant 10 and ferro-phosphorus, respectively. The structures of the bars refined with EP1136 and ferro-phosphorus were similar and fairly satisfactory (see Figs. 8 and 9), although the size of the primary silicon particles was nearly 0·06 mm. The Nucleant 10, however, produced less satisfactory structures as the average primary silicon particle size was about 0·08 mm. (Fig. 10).

Particle distribution versus total phosphorus content curves have been prepared for the three refining agents investigated. These curves have been limited to the 1 in. diameter die-cast sections, as it has already been shown that coarsening occurs in the sand castings, due to the slower rate of cooling.

The technique employed involved counting the number of primary silicon

Fig. 5—1 in. diameter die-cast bar. Total phosphorus content of 0·0146 per cent introduced by Nucleant 10 (× 100)

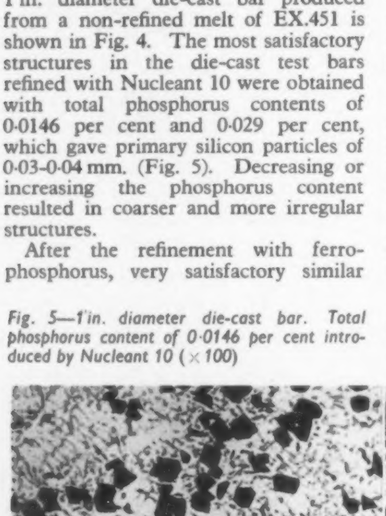


Fig. 6—1 in. diameter die-cast bar. Total phosphorus content of 0·008 per cent introduced by ferro-phosphorus (× 100)

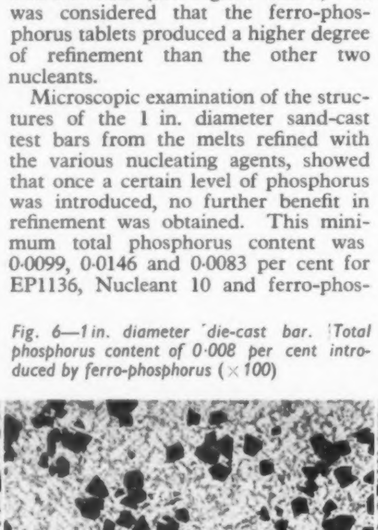
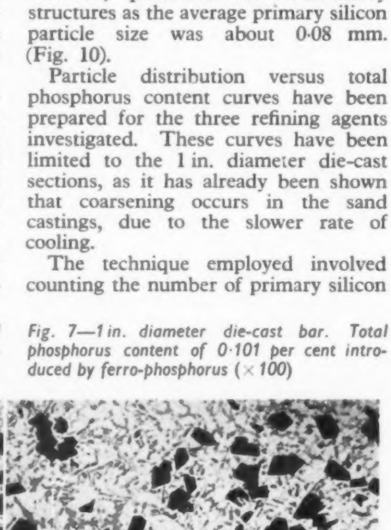


Fig. 7—1 in. diameter die-cast bar. Total phosphorus content of 0·101 per cent introduced by ferro-phosphorus (× 100)



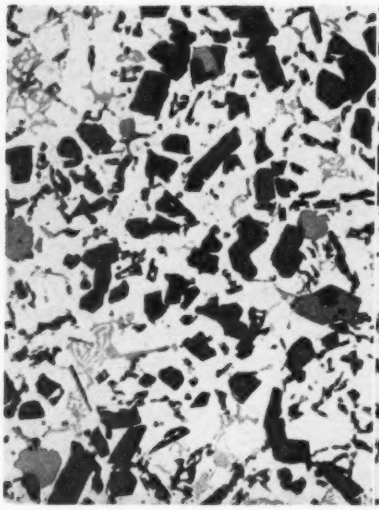


Fig. 8—1 in. diameter sand-cast bar. Total phosphorus content of 0·0099 per cent introduced by EP1136 (× 100)

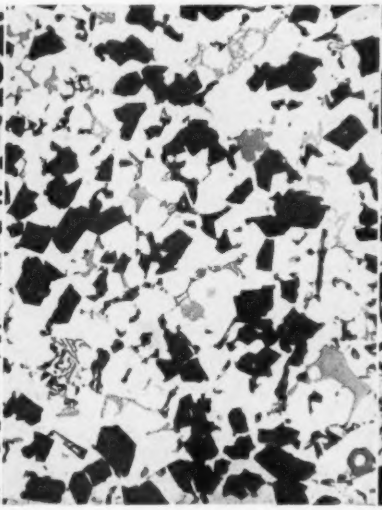


Fig. 9—1 in. diameter sand-cast bar. Total phosphorus content of 0·008 per cent introduced by ferro-phosphorus (× 100)

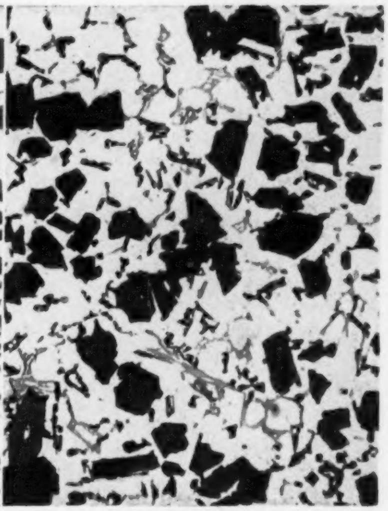


Fig. 10—1 in. diameter sand-cast bar. Total phosphorus content of 0·0146 per cent introduced by Nucleant 10 (× 100)

crystals present in a 75 mm^2 area, at a magnification of 100, for each of the total phosphorus contents in the three series. Three counts, each involving some 200-300 particles, were made on each specimen. The mean results are presented graphically in Fig. 11, where it will be seen that the introduction of 0·015 per cent total phosphorus by means of ferro-phosphorus, results in about 70 particles/cm^2 more than in the case of either EP1136 and Nucleant 10. As the machining and wear characteristics of this type of alloy are related to the size of the primary silicon particles and their distribution within the matrix, it is expected that the alloys refined by ferro-phosphorus will be the best from these viewpoints.

Comments

Consideration of both the tensile properties and microstructures of the 1 in. diameter die-cast and sand-cast bars shows that the best results for refining with EP1136, Nucleant 10 and ferro-phosphorus were obtained with total phosphorus contents of the order of 0·016, 0·015 and 0·012 per cent respectively. The results obtained on the ⅛ in. and ½ in. sections of the disc series confirmed that these amounts also applied to the refinement of the thinner section die-castings. These total phosphorus contents were achieved by the addition of 10, 4 and 0·8 oz. of the corresponding nucleating agents, respectively, to 100 lb. of melt.

It appears that, in the case of the sand-cast test bars, although the phosphorus had some nucleating effect, the rate of cooling has not been sufficiently fast to prevent a certain amount of primary silicon crystal growth.

Effect of Process Variables

As it had been demonstrated that it was possible to refine satisfactorily the primary silicon phase in hyper-eutectic aluminium-silicon alloys by the introduction of phosphorus to the melts, attention was next given to determining the factors likely to be encountered during the processing of the melts which would influence the efficiency of nucleation. The effect of section thickness and rate of cooling have been discussed in the previous sections on refining and the effects of pouring temperature, contamination with sodium, holding time, remelting, and degassing will now be considered.

The EX.451 melts prepared for the various experiments in this connection were processed as described in the preceding sections and nucleated with ferro-phosphorus tablets to give total phosphorus contents of approximately 0·015 per cent. The samples taken to enable the effects of the various processing variables on the efficiency of nucleation to be assessed were die-cast disc components and 1 in. diameter die-cast bars.

Pouring Temperature

Examination of the binary aluminium-silicon equilibrium diagram shows that in the case of the aluminium-23·5 per cent silicon alloy (EX.451) there is a wide freezing range, with the liquidus occurring at about 770°C. and the solidus at 577°C. It was decided to heat the refined melt to 800°C., cast off samples, then to increase the temperature to 850°C., cast samples, and finally to allow the melt to cool, taking samples at 800°, 750° and 700°C.

The flat portions, together with the stems of the various disc castings and the test bars, were examined microscopically. It was found that there was little difference between the microstructures of the specimens cast with pouring temperatures of 800°C. (heating and cooling) and at 850°C., in each case the primary silicon particles were well nucleated, evenly dispersed and of the desired size. However, pouring temperatures of 750° and 700°C., i.e. below the liquidus, had resulted in a serious coarsening of the primary silicon crystals.

There was no significant difference in silicon particle size between the thinnest and thickest sections, i.e. ⅛ in. and 1 in. respectively, cast at each temperature.

Sodium Contamination

For the series of experiments to determine the effect of contamination

● Ferro-Phosphorus
X EP1136
△ Nucleant 10

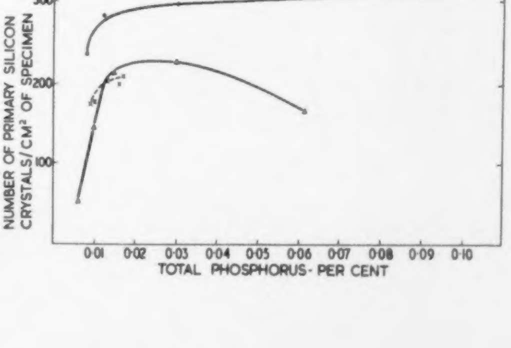


Fig. 11—Relationship between total phosphorus content and the number of primary silicon crystals/cm² in 1 in. diameter die-cast bars

of the melt with sodium, a sodium-containing flux, Coveral 11, was employed, and disc castings and 1 in. diameter die-cast bars were poured at the same temperatures detailed in the preceding section.

Examination of micro specimens taken from the various samples showed that very little refining had taken place, and all the structures, irrespective of the pouring temperature, showed large, irregular shaped primary silicon particles together with aluminium dendrites and a relatively fine globular eutectic.

Effect of Holding Time

A melt of EX.451 was prepared in the normal manner, using Coveral 65 as a cover throughout. After raising the melt to 800°C., the test castings were poured; this temperature was then maintained and further samples were cast at half-hourly intervals over a total period of 2½ hr.

The microstructures of resultant discs and bars were examined, and it was found that a slight, but insignificant, coarsening had occurred with holding times of longer than 1½ hr.

Effect of Remelting

A further melt was nucleated and samples cast at 800°C., after which the remainder was poured into open chill moulds. These ingots were remelted, without additional refining, the temperature raised to 800°C., and further samples cast. The latter procedure was repeated three times.

Examination of the microstructure of the test castings showed that a very slight coarsening of the primary silicon particles occurred with each successive remelt, but, even after four remelts, the size of the silicon crystals was still acceptable, being about 0·06 mm.

Effect of Degassing Media

It has been shown that relatively high processing and casting temperatures (780-800°C.) are necessary for the production of hyper-eutectic aluminium-silicon castings with satisfactory microstructures and properties. At these high temperatures, the rate of gas absorption will be far higher than with the more conventional aluminium-base casting alloys, which are seldom taken above 750°C. during processing.

Thus, the degassing techniques employed will be critical, not only since there will probably be larger quantities of gas to remove, but also because the degassing treatment must not decrease the effect of the aluminium phosphide nuclei. The following degassing media appeared to offer some promise and were selected for trial: Foseco 190 tablets, Foseco 450 tablets, nitrogen and chlorine. The first two preparations are sodium-free, high temperature degassing agents, the difference being that the hexachlorethane is compounded in a ring-shaped refractory base of carefully controlled porosity in the 450 tablets, but in standard tablet form in Degasser 190.

Attempts were made to compare the amounts of gas present after the various degassing treatments by means of the reduced pressure test, but inconsistent results were obtained. However, a qualitative technique which gave reasonably reproducible results was then developed, and this involved the use of a cross-section of a fairly heavy die-casting, about 4 in^2, smooth machining and grinding the face and, finally, Ardrox dye penetrant testing to reveal the gas porosity.

It was found that the hyper-eutectic aluminium-silicon melts produced under the closely controlled conditions obtaining in the Research Division contained somewhat lower gas contents than larger melts processed under production conditions. It was decided, therefore, to compare the efficiency of the various degassing agents in treating both normal melts and melts which had been deliberately gasified by rabbling in Coveral 65.

The Foseco 190 tablets, added in the ratio 5 oz. per 100 lb. of melt, were held at the bottom of the pot by means of a perforated hemispherical plunger. It was found that very little degassing had been effected, even in the case of the deliberately gassed melt, and the treatment had little effect on the refined primary silicon particle size in the resultant test castings.

The Foseco 450 tablets (6 oz. per 100 lb. melt) were held at the bottom of the crucible by means of an iron hook. This procedure did not produce complete degasification, and a second treatment with 6 oz. of the tablets was necessary to effect a satisfactory level of degassing. The "double" degassing treatment did not produce a coarsening of the primary silicon crystals.

Nitrogen, introduced by means of a silica tube, was bubbled gently through a 30 lb. melt for 5 min. This treatment satisfactorily degassed the normal melt but was less effective in treating the gasified melt than the double degassing with Foseco 450 tablets. Increasing the time of degassing with nitrogen produced a significant coarsening of the primary silicon particles.

Treatment with chlorine for 5 min., using a graphite tube, satisfactorily degassed both the normal and high gas content melts, but had no effect on the size of the primary silicon crystals. The last observation is at variance with British Patent No. 807934, which claims that treatment with chlorine, after nucleation with phosphorus, will produce an additional refining effect.

It was decided to investigate further the effect of treatment with chlorine on the primary silicon phase, and chlorine was passed through melts of a binary aluminium-23·5 per cent silicon alloy and of more complex hyper-eutectic aluminium-silicon alloys, including EX.451, for periods up to 30 min. In no case was any additional refinement observed and, with times greater than 10 min., the primary silicon particles became progressively coarser until, after treatment for 30 min., the nucleating effect of the phosphorus was almost completely destroyed.

Effect of Heat-Treatment

It is not intended in this present article to deal thoroughly with the effects of heat-treatment on hyper-eutectic aluminium-silicon alloys, although some reference to heat-treatment is necessary.

A precipitation or stabilizing treatment at 160°-200°C. has no effect on the microstructure of EX.451, but produces increases in strength of about 2-3 and 1-2 tons/in^2 for die- and sand-cast material, respectively.

Full heat-treatment, involving solution treatment at 515°-540°C., however, has more important effects. The acicular eutectic background is rounded off and the strength is increased by about 6 tons/in^2 for both sand- and die-castings. It is expected, therefore, that better machining characteristics and surface finish will be obtained with hyper-eutectic aluminium-silicon alloys in the fully heat-treated condition.

(To be concluded)

Vacuum Distillation of Lead and Tin

WORK has been carried out at the U.S. Bureau of Mines on the vacuum distillation of some of the more volatile metals, such as cadmium, zinc, and magnesium from lead and tin. Evacuation within a distillation apparatus allows rapid diffusion of vapour away from the evaporation surface and prevents reaction of the vapour with residual gases. A reduction of pressure to several tenths of a millimetre makes possible practicable distillation rates, at temperatures for which the partial pressure of the metal vapour exceeds 10^{-3} atmosphere.

The rate and selectivity of distillation depends primarily on the volatility and molar ratios of the alloy metals, and their chemical activity to each other. For very rapid evaporation or low concentration of the more volatile constituent, the rate is determined by the rate of diffusion of the evaporating metal to the surface of the melt.

Cadmium, zinc, magnesium and tellurium were found to volatilize readily from both lead and tin. Cadmium and zinc can be removed readily down to about 0·1 at. per cent, subsequent removal being very slow. For less volatile metals, or such metals as magnesium, the practicable limit is about 1 per cent. Tellurium appears to volatilize as an intermetallic compound rather than the pure metal. Antimony could not be removed from lead at 1,000°C.; the condensate was nearly all lead. Antimony, bismuth and lead were removed from tin.

Die-Casting Review

Overcoming Porosity

CASE HISTORY EMPHASIZES THE IMPORTANCE OF FEEDING

IN pressure die-casting, more than in most foundry processes, there are few methods that can strictly be termed incorrect, and success of a given runner system or of the positioning of a feed is largely the outcome of experience with certain machines, with castings of similar type, with speed of production, and so on. Indeed, many die designers would agree to the proposition that there are no rules one can follow in die-casting practice, and every designer has to build up his own body of experience on certain very broad fundamentals. Expressed in a different way, this means that in practice there are so many variables to be considered in the design of a die for any casting that the most the designer can do is to achieve a compromise.

To achieve such a compromise, the designer has to assess the effects of the alloy being cast, injection speeds and cycling rates, trimming processes to be used, surface finish desired, wall thickness, total weight of metal cast, and whether burrs or ejector pin marks can be tolerated, to mention but a few of the factors involved. Small wonder, therefore, that two designers rarely agree upon what constitutes a sound design. Moreover, with such considerations in mind, it does not seem so surprising that when an order is taken away from one foundry and the dies placed at another, it is not uncommon for the latter to be unable to produce sound castings from them.

The successful design, then, is one based on a compromise achieved largely as a result of experience, and this article describes experience of feeding a particularly "tricky" casting in which porosity was difficult to eradicate.

The casting shown in Fig. 1 is the top plate for a fuel metering device. On its upper side, there is a circular recess formed by a wall around which are cast 12 bosses and six dogs or tongues. In the centre of this recess is a shallow counterbore and a $\frac{1}{4}$ in. diameter hole. Around the plate itself are a further 20 cored holes, following roughly the escutcheon shape of the plate. Another boss has a cored hole with splines passing through it.

The underside of this casting has a pattern of ribs to improve strength and assist feeding for the various bosses. Four steel inserts are cast-in.

Originally, this top plate was produced as a zinc die-casting by George Kent Ltd. for use in one of their assemblies, and at that time it was being cast on an Edgwick cold chamber machine with low injection pressure. In order to obtain rapid filling of the cavity and avoid cold shuts, a splayed-out gate was used, joining the casting all round its lower edge as indicated in Fig. 2. With this feeding system, the zinc alloy castings were reasonably satisfactory, although even in zinc some porosity occurred and the castings had to be impregnated in order to withstand the pressure test specified —that no leak should be apparent when immersed in paraffin and subjected to 250 lb/in.^{2}

When it was decided to use the product in relation to one of the highly specialized aircraft fluids—methanol — it became necessary to change to aluminium, and an outside supplier was sought. The order was placed with J. V. Murcott and Sons Ltd., who began production on a Lester 1 C C cold chamber machine.

The change to the light alloy provided an opportunity for modifications to the die to be made and, as is customary with aluminium, a narrower gate was used (Fig. 3). In the new feeding system, a gate some 2 in. wide and roughly rectangular in section was led into the lower edge of the die. At this point, and directly in the path of the injected metal, were three core pins, two $\frac{1}{4}$ in. diam. and one $\frac{3}{16}$ in. diam. To avoid undue maintenance and the constant replacement of these pins, as well as the risk of distortion to the pins and consequent jamming of the casting in the die, it was considered advisable to remove the core pins and drill the holes after casting.

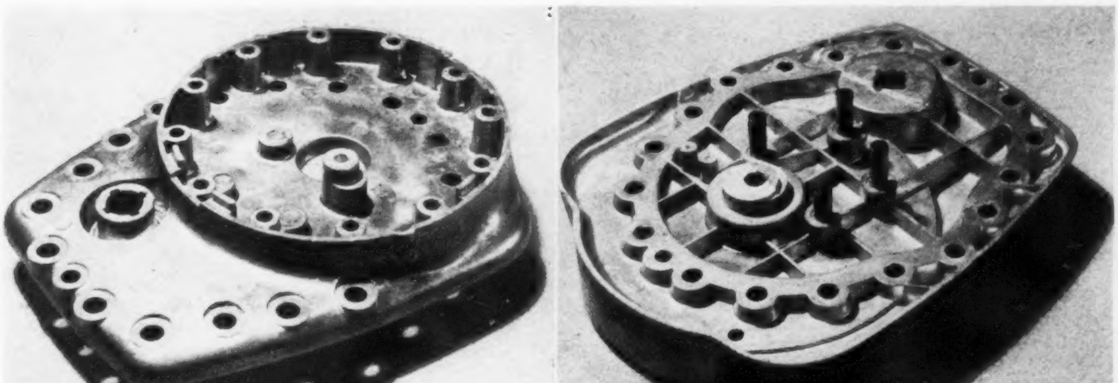
This temporary arrangement proved reasonably successful, and much of the porosity that had been encountered previously was eliminated. A proportion of the castings, however, still exhibited porosity and some impregnation was necessary, but the trouble was insufficient to justify further concern and die modification.

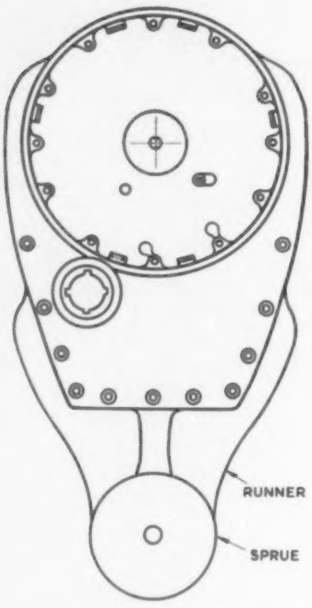
The die ran in this way for some four years and, subsequently, production programming at the foundry led to the die being modified to suit a Polak machine.

This change necessitated a re-positioning of the feed and enabled Murcotts to adopt a central feeding system that had proved successful with a variety of other castings.

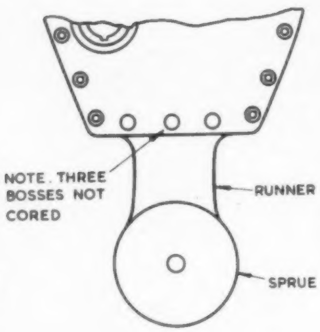
In the new die, the bottom feed was removed and the 3 core pins replaced. The boss on the underside of the plate was selected as the point for the location of the gate, which was now circular

Fig. 1—The top plate for a fuel metering device, showing (left) the detail of the top surface and (right) the underside with cast-in inserts. The position of the centre feed can be seen where the sprue has been cut from the centre boss

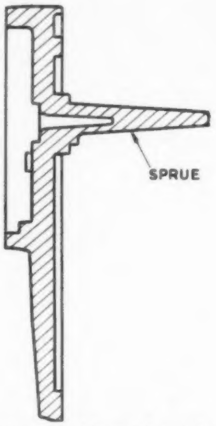




Left: Fig. 2—The original feeding system for the die-cast top plate



Right: Fig. 3—Runner narrowed and three cored holes removed



Extreme right: Fig. 4—Section through casting showing centre feed to underside

in section, and offset slightly from the centre of the boss (Fig. 4). In the other half of the die, the pad forming the counterbore and the core pin directly in the path of the metal acted as a spreader.

This system immediately improved the castings and porosity occurred so rarely that impregnation is no longer necessary, and scrap is negligible. Subsequently, a new die was made for producing the castings on the Polak machine, but this die was later adapted to suit a new V300 Buhler machine. The centre feed was retained, and production has proved satisfactory.

To summarize, Fig. 2 represents the casting from the original zinc die with wide flat runner and gate working at low injection pressure with moderately satisfactory results. Fig. 3 depicts a casting from a die designed for zinc with reduced runners and re-positioned heavier gating allowing increased pressure both on die and metal, this arrangement enabling the die to be worked with zinc or aluminium. In Fig. 4, the arrangement of the new die is shown with centre feed for use on a vertical feed machine giving extreme pressure on metal with short metal flow, a scheme that gave extremely successful results.

Plunger Lubrication for Die-Casting Machines

An automatic lubricant injector which minimizes the problem of plunger lubrication in pressure die-casting machines, where the use of heavy lubricants is generally considered essential, has been introduced by Foundry and Metallurgical Equipment Co. Ltd., Netherby, Queens Road, Weybridge, Surrey.

With the current trend towards automation, the problem of plunger lubrication has become more acute. The efficient action of a machine is dependent upon the plunger and its sleeve, and undue wear on these parts, caused by lack of consistent and thorough lubrication, leads to sticking of the plunger and failure to sustain the injection pressure.

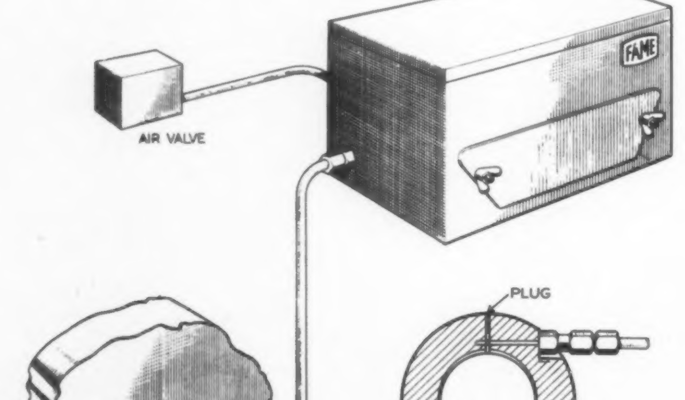


Diagram showing general arrangement of a "Fame" installation for plunger lubrication

The injector is a two-stage unit capable of dispensing heavy graphite-bearing compounds. The first stage draws the lubricant from a supply tank and pumps it to the second stage at a pressure of about 200 lb/in^2. From the second stage, the lubricant is pumped at pressures up to 1,500 lb/in^2 and in quantities from 0·045 in^3 to less than 0·005 in^3. The quantity is controlled with steel distance pieces which limit the intake of lubricant. The pumping system has a fully scavenging action, which ensures that the right measure is delivered every time and prevents build-up within the system.

On a pressure die-casting machine, an injection is made after every cast to ensure consistent but not excessive lubrication and there is no danger of castings suffering oil contamination. The efficiency of the lubrication introduces an economy in lubricant and reduces wear on both plunger and sleeve.

The unit operates from a compressed air supply of 60 to 150 lb/in^2 and can be controlled by an air pilot, a solenoid or a mechanical roller valve.

Explosive Metalworking

Explosively-formed corrugated sleeve (on left) with corrugated sleeve in Nichrome (right) and examples of tube with a cermet core

ENABLING tasks to be performed which are now beyond the scope of conventional equipment, promising future developments can be expected in explosive metalworking because of the unique operations to which it can be adapted. At present, use of the process is limited by the lack of experienced personnel and by the safety hazards. However, the method has economic advantages because of the low capital investment required, and can produce large parts and unusual shapes. These are some of the points brought out in a study of this process recently made at the Battelle Memorial Institute, Columbus, Ohio, by C. C. Simons.

Certain materials, when subjected to an impulsive load, can withstand momentary stresses well above their static fracturing stress. This basic principle makes explosive metalworking possible, and though it has been recognized for over half a century, the application of an impulsive load for metalworking received little attention prior to 1957. However, the need to form intricate shapes from high-strength refractory metals, and large parts from these and other materials, has focused attention on this process by which the tremendous energies necessary to form these shapes can be generated.

Both low (deflagrating) and high (detonating) explosives are used in the process; the former have burning rates of hundreds of ft/sec., and generate pressures of 100,000 to 300,000 lb/in^2, depending on the degree of confinement, while detonating explosives produce higher pressures and a reaction zone travelling at much higher velocity. The shock wave in the latter case produces a constant rate of energy release regardless of the degree of confinement.

Forming

In practice, the explosive is either in intimate contact with the workpiece, or, in "stand-off" operation, the charge is located at a predetermined distance from the workpiece, and the energy is transmitted to it through a transfer medium such as air or water. In the latter instance, the working pressure can be varied by adjustment of a number of factors, such as the size and type of charge and the degree of confinement.

During the explosive treatment, the metal retains its ordered state, and at no time assumes the disordered state of a real liquid. The severe plastic deformation which it undergoes is caused mainly by shear mechanisms that result in grain-boundary distortion, slip, and shock-twinning.

Applications using stand-off charges include the forming, flanging, and sizing of sheet metal and plate; contact charges are employed in controlled work-hardening, extruding, forging, cutting, and metal-powder compacting. Examples include the forming of nose-cones, railway tanker heads, rocket nozzles, and fuel tanks; the materials used have included titanium and its alloys, cobalt alloys, stainless steel, and many aluminium alloys. Some of these applications are considered in more detail below.

The preferred technique for explosive forming operations is to employ a high explosive in an open (unconfined) system, usually with water as the transfer medium. The use of low explosives for this application has not been widely adopted, as relatively elaborate tooling is required to provide the necessary confinement. In a typical example, using high explosives, bulkheads are formed on a concave die from a flat workpiece laid over it at the bottom of an open vessel filled with water; the space between the workpiece and the die is evacuated and a charge is detonated in the water, causing the workpiece to be pressed into the shape of the die.

High final densities and green strengths have been attained in the explosive compaction of metal powders —of the same order as those normally achieved by pressing and sintering. In short production runs, costs can be minimized by the use of disposable dies. A potential application is in compacting metal powders that are difficult to process by conventional techniques.

Welding, Hardening and Forging

Explosive welding can be effected by placing the two metals in contact and subjecting them to normal loading by an underwater stand-off charge. Aluminium and copper joined in this way form a weld stronger than the aluminium. Contact charges giving asymmetric loads, and with an angularity between the materials, may also be used for welding; the bond is formed by surface jetting of the metals.

Explosive hardening of metal surfaces is accomplished by detonating a high explosive charge in intimate contact with the surface. An increase in hardness in manganese steel has been obtained by this method at depths of up to 2 in. below the surface. Copper plates have been hardened from Rb 20 to Rb 100, without fracturing, by explosive methods. The du Pont company has described a technique for hardening rock-crusher jaws using explosives.

Stand-off high explosive charges have been employed for the forging of steel and aluminium alloys. Explosively forged 7075 aluminium was found to

have a tensile strength and elongation 7 per cent and 30 per cent higher, respectively, than the normal values. Finally, the punching of holes has been performed by both high and low explosives; equipment is now on the market which uses energy produced by the deflagration of a low explosive to drive a metal punch.

Further research is still needed to elucidate fully the mechanics involved in the application of an explosive force, and the resultant effect on the mechanical properties of a range of materials. Nevertheless, in the short space of time during which explosive metalworking has been extensively studied, the progress made has clearly been remarkable.

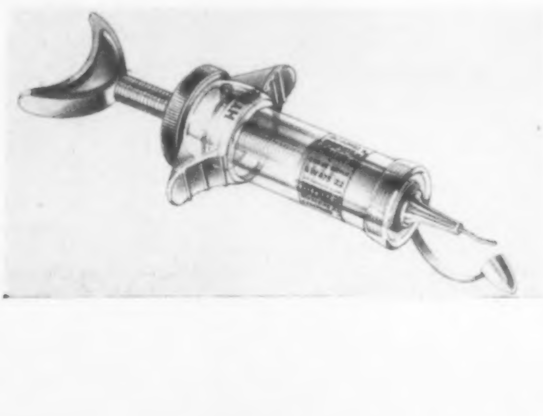
Feeding Diamond Lapping Compounds

MINUTE quantities of diamond compounds are needed for each metallurgical grinding and lapping operation, and great economies can be made if these are accurately dispensed. Such compounds are used in preparing metallurgical specimens for the microscope, where the cleaner cutting action of diamonds over other abrasives prevents surface constituents in the metal from being disturbed. They are equally important in the manufacture of precision instruments, radar and gyro mechanisms, the precision fitting of turbine blades or the polishing of paper glazing rolls and engravers' plates for the printing industry. Steel moulds for making pills or plastics must be diamond-lapped to a high finish; so must the ceramic nose cones of rockets and tungsten carbide dies used in wire drawing.

A new micrometer-controlled syringe, known as the Hyplicator, has been introduced by Engis Limited, of Maidstone, for the accurate metering of their "Hyprez" grinding and lapping compounds. These compounds, which may cost up to £120 per ounce, are made from diamond particles between 1/10 micron (0·0001 mm.) and 90 microns (0·09 mm.) in size, subdivided into 12 separate grades and permanently suspended in a variety of special pastes. Between them they cover the whole range of cutting and finishing processes on soft, hard and very hard materials.

Surfaces brought to a high finish in this way are naturally resistant to atmospheric corrosion, since they contain no pores or crevices in which moisture could lodge. They might, however, be damaged by some of the products of corrosion — notably crystalline copper sulphate or verdigris — which could result from the use of a metal applicator gun. For this reason, the body of the Hyplicator is made of moulded nylon, with a threaded nylon shaft which engages with a knurled micrometer screw (also made of nylon) in the top of the barrel. The shaft is connected to a Neoprene plunger, whose base has been given a greater radius of curvature than the nozzle cup into which it descends. This ensures that every vestige of compound is forced into the centre of the cup and down the nozzle as the syringe empties. The whole nozzle fitting can then be removed and attached to a freshly loaded syringe, so that none of the compound is wasted.

Diamond compounds are also used at nuclear research establishments for grinding and finishing titanium, zirconium, tantalum and other rare metals including beryllium, whose highly toxic dust makes it necessary to machine the material by remote control in a totally enclosed cabinet. Under these conditions Hyprez compounds can be metered on to the work by means of an electric motor with a rubber driving wheel which bears on the knurled screw in the top of Hyplicator.



The micrometer-controlled syringe for applying diamond lapping compounds

Obituary

Sir A. Croft

IT is with regret that we record the death of Sir Arthur Croft, chairman of Crofts Engineers (Holdings) Ltd. He became joint chairman in 1920, governing director in 1936, and chairman and managing director in 1948 when the company was made public. He retired in 1953.

Mr. W. Pollock

WE also regret to record the death of Mr. William Pollock, a son of the founder of Accles and Pollock Ltd. For some years prior to his retirement he had been a departmental manager at the Oldbury works.

New Plant & Equipment

Automatic Polishing

FOR automatically polishing profiled components, such as car window vent frames, clock bezels, profiled metal beadings, shaped strip surrounds, and the like, B. O. Morris Ltd., of Coventry, have introduced their Model CFT.40 machine.

The workpiece is held on a quick action jig which incorporates a chain drive following both concave and convex contours; once the jig is engaged in the variable speed drive sprocket it traverses through its whole length against the polishing mop, or abrasive band attachment.

Usually, only one polishing head unit is employed, with liquid compo feed arrangement; while the standard table size is 40 in × 30 in., this can be extended to suit any requirement by outrigger sections; also, two machines can be coupled as a duplex arrangement for two pass work.

This machine is well suited to regular small run work, where the expense of a large capacity automatic plant would not be justified, or where the length or shape of the component is awkward.

The Morrisflex Hammond CFT. 40 automatic profile polishing machine

Vacuum Treatment

ENABLING temperatures in the region of 1,500°C. to be attained and accurately controlled, a high temperature vacuum furnace, introduced by Goulding and Partners (Consultant Engineers) Ltd., Essex Road, London, W.3, takes advantage of the high temperature characteristics of tungsten or molybdenum and incorporates a resistance heating assembly using, in this case, helical tungsten elements. These are freely supported from two suitably spaced ring formers, the shape and size of which may be adjusted to accommodate individual requirements.

The hot zone provides a chamber in which brazing, sintering, melting and outgassing experiments may be conducted under vacuum. Mechanical manipulators may be provided to meet particular needs. Heat losses are reduced to a minimum by the introduction of a number of circumferential and end radiation shields.

The use of ceramic formers, especially in the hot zone, has been avoided, thus obviating the possibilities of contamination.

A manually controlled variable transformer enables the power requirements to be adjusted to suit the element characteristics. When stable and desired conditions have been attained, the temperature may then be controlled automatically by a thermocouple, in conjunction with a suitable recording or controlling instrument, and a mercury relay.

Vacua in the region of 10^{-5} Hg at 1,000°C. working temperature are obtained by the use of standard backing and diffusion pumps. Suitable vacuum gauges are provided.

The mechanical features include a counterbalanced water-cooled stainless steel furnace case.

High temperature vacuum heat-treatment furnace introduced by Goulding and Partners (Consultant Engineers) Ltd.

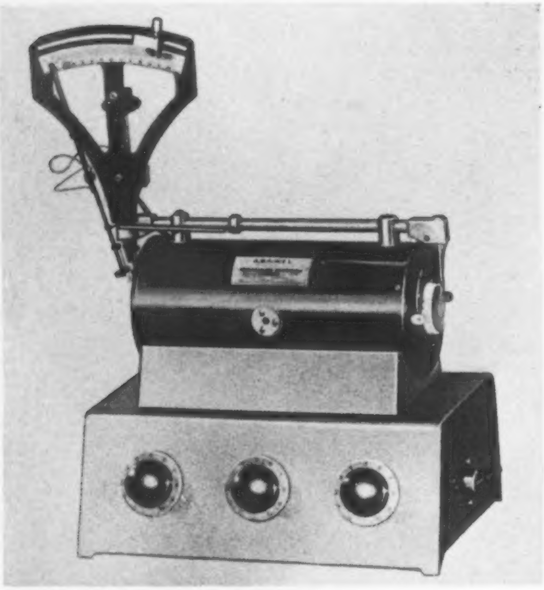
The backing pump is isolated to minimize vibration. The compact and self-contained instrument panel includes the electrical switch control system. This furnace is designed and constructed as a series of unit assemblies, thus facilitating servicing or subsequent modifications in the laboratory. The outer surfaces are panelled in sheet steel and treated with a durable stove enamel.

Level Indication

AFTER extensive field trials in various industries, an instrument known as the "Levelrator" has been introduced by Thomas Industrial Automation Limited, Station Buildings, Altrincham, Cheshire. The "Levelrator" not only gives continuous indication of the contents of silos, tanks, hoppers, etc., but it will also operate visual and/or audible alarms. The equipment uses one electrode only for both continuous measurement and control. Alarm points can be set to operate over the full length of the electrode to suit the particular application.

The electrode system can be of the rigid variety for a small vessel and the flexible type when the depth of the container exceeds 6 ft. The limitation of length of electrode is really dependent upon the particular application, but electrodes are available up to 60 ft. in length.

The high or low level control points are completely independent of the



Chevenard-Joumier precision laboratory furnace with thermostatic regulator introduced by Shandon Scientific Co. Ltd.

indicating instrument, and the relays are operated by a specially designed electronic circuit. The long term stability and reliability of this equipment are exceptionally high, and it is virtually unaffected by normal mains and temperature fluctuations.

The control unit can be situated up to 150 ft. from the electrode head unit. Remote indicators can be supplied to customers' requirements, and sited anywhere on the plant. The built-in calibrating instrument has a scale length of 2½ ft., and this is graded in 2 per cent divisions and can, if necessary, be used as a local indicator.

The "Levelrator" can be supplied in multipoint units which allow centralization of all the control and indicating meters.

Fume Cleaning

FOR collecting solids from all kinds of industrial fumes, smokes or exhaust gases, a venturi scrubber has been introduced by Ambuco Ltd., of Standbrook House, 2-5 Old Bond Street, London, W.1.

The scrubber has three special features. They are: the means of introducing the water to achieve the "double scrubbing" action; the method of varying the water droplet size to deal with varying types of solid particles; and lower pressure loss, with consequent lower power requirements.

In the Ambuco scrubber (which is made under licence from Waagner-Biro) the water is introduced ahead of the venturi by means of a special nozzle spraying directly into a specially shaped entry. The design of the entry is so arranged that the gases are compelled to pass through two complete cones of water.

In the first cone, the water droplets are of a relatively large size and are primarily effective in collecting the coarser solid particles. In the second cone (produced by the venturi entry shape), the droplets are considerably finer and their velocity is reduced.

At the same time, the velocity of the gas and dust particles increases as it passes the venturi. This results in ideal conditions for the collision of the dust particles and fine water droplets, with consequent maximum collection efficiency of the finest of particles.

For effective gas scrubbing, the size of the water droplet must be varied to meet varying sizes of solid particles. In the Ambuco scrubber, droplet size is controlled by positioning the water introduction nozzle relative to the venturi entry.

Thermal Treatment

A RANGE of precision laboratory furnaces with exceptionally high stability of temperature (±0·25°C.), an interchangeable drum control for thermal cycling, and facilities for heat loss compensation at the end of the tube, has been introduced by Shandon Scientific Company Ltd., 6 Cromwell Place, London, S.W.7.

In the standard range there are three models for maximum temperatures of 1,050°C. with tube sizes respectively of 35 mm. I.D × 290 mm. length (for operation on 115 V A.C.), 60 mm × 450 mm. (220 V A.C.) and 75 mm × 700 mm. (220 V A.C.); and two models for maximum temperatures of 1,250°C., with tube sizes of 35 mm × 290 mm. (115 V A.C.) and 60 mm × 450 mm. (220 V A.C.). Two special models for maximum temperatures of 1,500°C. are also available, with tube sizes of 16 mm × 250 mm. (115 V A.C.) and 35 mm × 400 mm. (220 V A.C.).

Standard models may be controlled either by a thermostatic regulator or a chronograph drum control for thermal cycling, these temperature - control arrangements being easily interchangeable by the user.

The thermostatic regulator is an ingenious and reliable mechanism, enabling the furnace temperature to be controlled within ±0·25°C. at any desired level below the maximum. It is interchangeable on the standard models with a chronograph drum control for thermal cycling.

The drum is clockwork-operated as standard, but an electrically-driven version is available as an alternative. It carries a temperature chart on which the desired thermal cycling programme is marked out by a strip of thick cardboard. In operation, the drum revolves at a set speed (the gearing arrangements provide two speeds), and, as the furnace heats up, a specially-designed contact on an arm connected to the dilatable wire moves across the drum. When it meets the cardboard, the relay operates and the current is cut off. In this way the contact follows closely the edge of the cardboard strip, alternately making and breaking the circuit to the windings, and thus holding the temperature to the planned programme.

All models may be mounted vertically or horizontally, and may also be fitted with a water jacket, e.g. for use in a glove box.

The two special 1,500°C. models are developed from the standard types. They are available only with a chronograph drum control, which is not interchangeable with a thermostatic regulator, and incorporate special windings of platinum-rhodium wire.

Metal Finishing

THIRTY-TWO Papers on electrodeposition and allied processes, organic finishes and chemical milling, are the major contents of the recently published "47th Annual Technical Proceedings" of the American Electroplaters' Society. The Papers range widely over the metal finishing field dealing with such subjects as statistical quality control of plating processes, chemical reduction of nickel-phosphorus alloys from pyrophosphate solutions, cleaning techniques, corrosion protection with decorative chromium, gold plating, dual chromium systems, the performance of nickel and chromium plated zinc die-castings and a variety of others.

At the end of the book, a report of the discussion that followed the presentation of the Papers at the A.E.S. 47th Convention is given; reports of this meeting and other data relating to the Society are given at the front of the book. Additional copies have been made available at $18 in the U.S.A. and $22 outside the U.S.A., and may be obtained from the Society, at 443-445 Broad Street, Newark, N.J., U.S.A.

Industrial News *Home and Overseas*

South Bank Buildings

In July next, some 1,500 architects from all over the world will meet in the Royal Festival Hall, London, at the sixth Congress of the International Union of Architects to discuss the theme "New Techniques and Materials—Their Impact on Architecture". In order to provide suitable accommodation for the Congress headquarters, and also the international exhibition that will illustrate the theme of the Congress, two new temporary buildings are to be built on the South Bank, near the Festival Hall.

These two buildings are in sharp contrast to each other. The exhibition building, designed to use available materials which could be put back into stock afterwards, will consist of a galvanized steel space frame standing on galvanized tubular steel uprights. The walls will consist of scaffold boards, the floor of concrete paving blocks, and the roof of polythene sheeting fixed to the space frame with timber battens.

The headquarters building is sponsored by **The British Aluminium Company Limited, Cape Building Products Limited** and **Pilkington Brothers Limited,** and the architect for this building has produced a design which is primarily dependent on the use of the basic materials supplied by the sponsor companies—glass, aluminium and Asbestolux — the components comprising these materials being fabricated away from the site.

This building has been planned with a large carpeted central hall flanked on two sides by administrative offices and services. An outstanding feature is the roof, composed of a mass of pyramids or tetrahedrons, each 8 ft. square on its base, made of aluminium sheet supplied by the British Aluminium Company Limited and also constructed by them. This roof has been designed to exploit the tensile strength of aluminium and it is understood that it will be one of the lightest ever devised. It is basically a rectangular grid and the underside will be open, with lighting effects produced by using small projectors clipped to horizontal timber members. The roof will be carried on tubular steel stanchions.

The alloy chosen for the manufacture of this pyramid unit is BA.60 (NS3), the upper grid structure is in aluminium alloy 25 WP, the elements being extruded tube 2½ in. external diameter, ⅛ in. thick. The illustration on this page gives some idea of the ultimate appearance of these two buildings. The exhibition building is seen at the rear and the headquarters building is in the foreground.

A Training Course

It has been announced by **Westinghouse Brake and Signal Company Limited** that a further "Introduction to Industry" training course will be held at their Chippenham works during the Easter vacation (April 10 to 14). This time it is for sixth form boys who will be taking G.C.E. "A" level examinations in scientific subjects in 1962.

This course is designed to give boys at first hand a good insight into the engineering industry, how it works, the training facilities available, and career prospects. Applications for further details should be sent to the Personnel Superintendent of the company at Chippenham, Wiltshire.

Trade with Guatemala

By a Decree published in the Guatemalan *El Guatemalteco* last month, the Government Order published in December last year prohibiting the export of non-ferrous scrap metal from both private and Government stocks has now been revoked.

Platers' Night

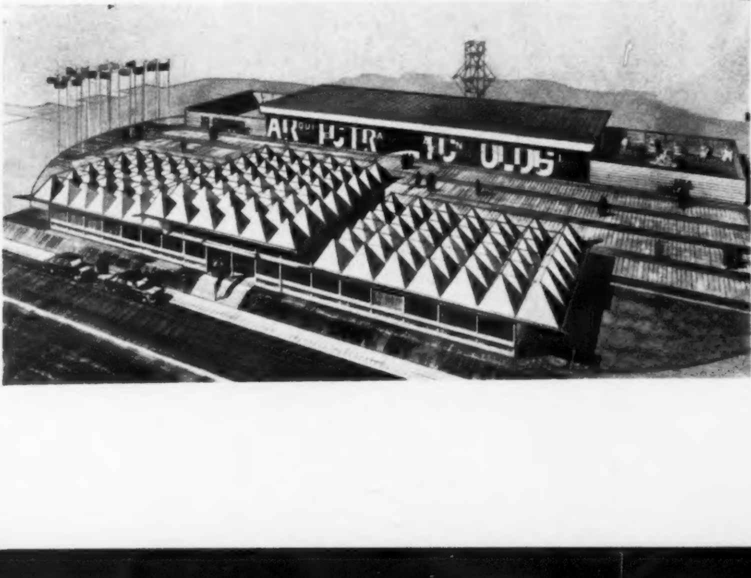
A popular feature of the programme of the London branch of the **Institute of Metal Finishing** is the annual practical platers' night, which this year is to be held on Friday, March 10, at the Constitutional Club, Northumberland Avenue, London, W.C.2, commencing at 6 p.m.

Full details of this event and applications for tickets (15s.) may be obtained from Mr. J. M. Shepherd, 18 Bentham Avenue, Sheerwater, Woking, Surrey.

Change of Address

It has been announced by **Almin Limited** that the administrative headquarters of the group is being transferred to Kynoch Works, P.O. Box 216, Witton, Birmingham, 6, with the telephone number of Birchfields 6171.

A general perspective drawing of the headquarters building and exhibition building for the Congress of International Architects on the South Bank, London. The headquarters building with its aluminium roof, glass walls and asbestolux partitions is in the foreground



Combustion Engineering

A residential refresher course for works and plant engineers has been arranged by the **National Industrial Fuel Efficiency Service** to be held at Prestatyn Holiday Camp from Monday, May 29, to Saturday, June 3. The aim of the course is to provide engineers concerned with the burning of substantial tonnages of solid, liquid and gaseous fuels on boilers and furnaces with an integrated series of lectures which will not only examine and review existing good practice, but will also introduce and consider the latest developments in the field of combustion.

Starting with a study of available fuels, the syllabus will include the principles of combustion for all types of boiler and furnace plant with the various auxiliaries and ancillary items of equipment, instrumentation and automatic control. The lecturers will be experts and will make liberal use of films, slides and other visual aids. Detailed and comprehensive lecture notes will be supplied to each student.

The inclusive fee for the course will be £12 12s. 0d. The director of studies will be Mr. W. Short, B.Sc., M.Inst.F., and brochures and application forms can be obtained from Mr. C. K. R. Davies, Secretary to the Course, National Industrial Fuel Efficiency Service, Baltic House, Mount Stuart Square, Cardiff.

A Correction

In the issue of this journal for 10 February, reference was made to the change of address of the Manchester office of **Deutsch and Brenner Ltd.** Unfortunately, the name of the street in which the new office is situated was given as Brazenose Street, but this, of course, should have read "Brazennose Street".

Testing Machines

News from **Nash and Thompson Ltd.** is that they are now marketing a wide range of creep and rupture testing machines, furnaces, and extensometers which are based upon equipment previously supplied to industry against special requirements.

Detailed descriptions of these machines are provided in leaflets which are available from the company.

A Birmingham Meeting

In a survey of the extrusion process, Mr. R. Chadwick, M.A., F.R.I.C., F.I.M., speaking at last week's meeting of the Birmingham Local Section of the **Institute of Metals,** outlined the development of the process from its beginnings to the present day. He drew particular attention to the problems of back-end defects associated with the unlubricated direct extrusion process, and the sub-surface defects which arise when partially-lubricated conditions pertain. Mr. Chadwick dealt briefly with glass lubrication and its advantages, before turning to the merits of the indirect extrusion process, and describing some of the tool arrangements used in this process and in cable sheathing.

In the discussion which followed, ques-

A large "spun" pressure vessel head produced by G. A. Harvey and Co. (London) Ltd., at their Greenwich works for exhibition at the forthcoming Leipzig Fair. The head has an inside diameter of 12ft. 6in. and it is dished and flanged from 1¾ in. thick stainless steel "Colclad" plate. The head weighs 6½ tons and was "spun" on a "Rotarpress", one of two such machines in this country

tions were raised regarding the relative yields of the direct and indirect processes, the shape of dies and containers, aluminium cable sheathing, lead and aluminium pipe production, the surface finish of extruded products, and temperature control during extrusion.

Lightweight Lighting Columns

What is stated to be the biggest installation of light alloy lighting columns ever undertaken in this country has just been completed. Some 665 of these "featherweights" have been erected in the Borough of Ilford under the direction of the borough engineer's department—part of Ilford's seven-year plan in which it is intended to re-equip their street lighting system.

These alloy columns were manufactured by **Alf'd Miles Ltd.,** a subsidiary of the Gloster Aircraft Company Ltd. and a member of the Hawker Siddeley Group. Many of the materials and techniques usually associated with the specialized manufacture of aircraft have been incorporated in these columns. A virtually climatic non-corrodible alloy to NS.5 is used, and a special welding technique has enabled the company to construct the columns in one piece, thus eliminating any tell-tale welding lines.

U.K. Metal Stocks

Stocks of refined tin in London Metal Exchange official warehouses at the end of last week rose 55 tons to 10,153 tons, comprising London 4,282, Liverpool 3,861 and Hull 2,010 tons.

Copper stocks fell 225 tons to 14,750, distributed as follows: London 950, Liverpool 11,575, Birmingham 100, Manchester 2,075, and Hull 50 tons.

Lead duty free stocks rose 25 tons to 7,288 tons, while in bond stocks fell 25 tons to 3,867 tons. All supplies were in London.

Zinc duty free stocks rose 96 tons to 3,076 tons, while in bond stocks fell 25 tons to 500 tons, comprising London duty free 985 tons and in bond 500 tons, Liverpool duty free 2,056 tons and in bond nil, Glasgow duty free 35 tons and in bond nil.

West German Aluminium

It is reported from Düsseldorf that West Germany produced 240,900 tons of aluminium semi-manufactured goods last year against 191,000 tons in 1959. Exports rose to 21,000 tons from 18,800 tons previously. The pace of orders received has become normal again after the difficult conditions experienced in the middle of last year, it was stated. This means that delivery terms can now be cut again, but orders still in hand will ensure full employment in the industry for the next few months.

O.E.E.C. Lead and Zinc Production

Total refined pig lead production in the O.E.E.C. countries, including the lead content of antimonial lead produced by smelters or refineries, provisionally amounted to 58,702 metric tons in January as compared with 69,081 metric tons in December. Total stocks, except stocks of remelted metal in the member countries representing 99 per cent of European production, totalled at end-January 54,212 metric tons, compared with 55,664 metric tons at end-December.

Final production figures for refined lead (excluding remelted metal) for December were given as follows: Austria, 945; Belgium, 7,537; Denmark, 790; France, 10,127; Germany, 8,296; Greece, 300; Italy, 5,150; Netherlands, 1,200; Spain, 7,587; Sweden, 5,479; U.K., 6,902; Morocco, 2,426: and Tunisia, 2,342.

Production of lead ores and concentrates in January provisionally totalled 32,078 metric tons of metal content, compared with 32,851 metric tons (revised) recoverable metal content in December. The level of production was about 9 per cent higher than in January 1960.

Production of lead ores and concentrates in December, in metric tons of recoverable metal, were: Austria, 456; French Commonwealth, 2,400; Germany, 4,266; Italy, 3,796; Norway, 198; Spain, 6,616; Sweden, 3,406; U.K., 200; Morocco, 9,586 (including an estimate of 25 per cent of the tonnage indicated) and Tunisia 1,927 (including an estimate of 30 per cent of the tonnage indicated).

Zinc production in O.E.E.C. countries totalled 72,162 metric tons in January, compared with 74,889 metric tons in December. In January, 30,405 metric tons were high grade and special high grade zinc, and 41,757 tons other grades. Stocks of refined zinc at the end of January totalled 48,856 metric tons, compared with 48,813 metric tons at the end of December.

Corrosion Problems

On Wednesday, March 8 next, the Newcastle Section of the Corrosion Group of the **Society of Chemical Industry** will meet at 8 p.m., in the Northgate Hall of the College of Further Education, Gladstone Street, Darlington, when Mr. J. D. Thompson, of the Cleveland Bridge and Engineering Company Limited, will speak on "Metal Spraying for the Protection of Bridge Structures".

Earlier in the day, members of the section will visit the works of the Cleveland Bridge and Engineering Company.

U.S. Scrap Exports

United States scrap dealers, fearful of possible export restrictions, applied to export twice as much copper scrap and copper alloy scrap in January as in December, according to informed trade sources. The Commerce Department granted licences to export a total of 71,874,200 lb. of copper and copper alloy scrap in January — more scrap than has been exported in any single month in recent years. In December, 30,218,500 lb. were licensed for export, and in November 1960 a total of 33,438,000 lb. were exported.

These sources said that this indicates that the licences granted in January were far in excess of anticipated exports. They noted that dealers are apprehensive that the Commerce Department will restrict exports following recent protests made by U.S. scrap consumers that scrap copper exports are sharply tightening the domestic supply.

U.S. Commerce Department officials, however, expressed doubts that exports will be restricted, but the dealers are taking no chances. Export licences once granted are not revocable without cause and are valid much beyond the month during which they are granted.

Malayan Tin Shipments

Tin shipments from Penang during the first half of February amounted to 2,981¾ tons, according to the Straits Trading Company. They comprised 55 tons to the United Kingdom; United States, 1,000; the Continent, 1,367¾; Japan, 215; Pacific, 13; India, 109¾; South America, 212¼; and Middle East, 9 tons.

Tin shipments from Singapore in the same period totalled 607¾ tons, comprising: 205 to the United States; the Continent, 395; Pacific, 1; and the Middle East, 6¾ tons.

Protection by Paint

On Wednesday next (March 1), a joint one-day Symposium is to be held at the Chamber of Commerce, Harborne Road, Birmingham, under the auspices of the Birmingham Productivity Association and

At the annual dinner of the Sheffield and North East Branch of the Institute of Metal Finishing (left to right)—Mr. and Mrs. A. A. B. Harvey and Mr. and Mrs. A. R. Knowlson

the Organic Finishing Group of the Institute of Metal Finishing.

The theme of the Symposium is "Protection by Paint", and recent advances in techniques used in the protection of metallic articles by painting processes will be dealt with by experts. They will emphasize the importance of correct cleaning and pre-treatment, indicate the latest types of finishes and methods of application, and examine the complete painting process with regard to cost.

The proceedings will open at 10 a.m. with an address from the chairman, Mr. M. A. Bennett, and the first morning session will commence at 10.10 a.m. The afternoon session will commence at 2 p.m. and the proceedings are timed to end at 4.20 p.m. Tickets for the Symposium are £3 10s. 0d. each, and will include morning coffee, lunch and tea. Full details may be obtained from the Secretary, The Birmingham Productivity Association, Chamber of Commerce House, 75 Harborne Road, Birmingham, 15.

Change of Name

Established in 1946 by the Fire Offices' Committee under the title of "Fire Offices' Committee Fire Protection Association", this organization has now changed its name to the **"Fire Protection Association"**. The association will continue to receive the financial support of the insurance companies which comprise the Fire Offices' Committee, and will continue to co-operate closely with the Committee on all points of mutual interest. This change of name will in no way affect the many activities which are aimed at reducing the number of fires, both in industry and in the home, especially in view of the present upward trend.

Tube Straightening

Within the last few months, the **Bronx Engineering Company Ltd.** have received orders in large numbers for their 6.CR type of tube straightening machine. The tube to be straightened is passed through three pairs of rolls, and the deflection on the tube, which is necessary in order to straighten it, is applied by adjusting both the centre rolls in relation to the outside rolls. All the top rolls can be adjusted vertically to suit tubes of differing diameters, and the bottom centre roll is also adjustable vertically to apply the deflection mentioned above. In addition, the angle of all the rolls can be adjusted so that whatever tube is being straightened, full line contact can be assured.

It should be noted that in the case of this 6.CR Series all six rolls are driven, and this enables straightening to be carried out without in any way marking the surface of the tubes.

The standard range of machines will straighten ferrous and non-ferrous tubes from 0·02 in. to 12 in. diameter, and, according to circumstances, the machines can be built for single-, two- or three-speed operation. Inlet and outlet troughs are available, and these can be of a simple type or, if required, can be arranged for automatic discharge of the tubes as they pass through the straightening machine.

Forthcoming Meetings

February 28 — Institute of Metals. Sheffield Local Section. Applied Science Building, The University, St. George's Square, Sheffield. "Martensite Formation." Professor W. S. Owen. 7.30 p.m.

February 28 — Society of Chemical Industry. Corrosion Group. 14 Belgrave Square, London, S.W.1. Cathodic Protection Panel Meeting. 6 p.m.

February 28—Institute of Metal Finishing. South-West Branch. Assize Courts Hotel, Bristol. "Principles of Barrel Finishing." W. Parry. 7.30 p.m.

March 1 — Institute of Metal Finishing. Scottish Branch. Grand Hotel, Charing Cross, Glasgow. "Plating of Zinc Die-Castings." S. W. Baier. 7.30 p.m.

March 1 — Institute of Metal Finishing. Organic Finishing Group. Chamber of Commerce, Harborne Road, Birmingham. Joint One-day Symposium with British Productivity Council. 10 a.m.

March 2—Institute of Metals. Birmingham Local Section. College of Technology, Birmingham. "Rating Sheet Metal Formability by Press Performance." D. H. Lloyd. 6.30 p.m.

March 2—Institute of Metals. London Local Section. 17 Belgrave Square, London, S.W.1. "Progress in the Electron Theory of Metals." Dr. J. A. Catterall. 6.30 p.m.

March 2 — Leeds Metallurgical Society. University Staff House, University Road, Leeds. "Grain Size—Three-quarters of the Key to Strength." Professor N. J. Petch. 6.30 p.m.

Men and Metals

Appointments to take effect from April 1 next have been made by the United Kingdom Atomic Energy Authority as follows:—**Dr. F. A. Vick,** O.B.E., to continue as director of A.E.R.E., Harwell; **Mr. R. V. Moore,** G.C., to be managing director, Reactor Group; **Mr. J. B. W. Cunningham,** M.I.Mech.E., to be managing director, Engineering Group; and **Mr. J. C. C. Stewart,** C.B.E., F.Inst.P., to be managing director of the Production Group.

Director of operations of Aluminium Limited, **Mr. M. P. Weigel,** of Montreal, has been elected a director of the company in place of the late Mr. C. D. Howe.

It is announced that **Mr. Charles F. Geddes** has been appointed a director of British Tin Investment Corporation and of its subsidiaries, B.T.I.C. (Overseas) and Tin Industrial Finance and Underwriting.

From New York it is announced that **Mr. John J. Birdcell,** formerly technical administrator, P. R. Mallory and Company, of Indianapolis, has been named co-ordinating engineer of the Copper Products Development Association, New York City.

It has been announced by Brightside Engineering Holdings Limited that **Mr. John S. Leigh** has been appointed assistant secretary to the company, and also secretary of the Brightside Foundry and Engineering Company Limited.

Appointments recently announced by Associated Electrical Industries (Rugby) Limited are as follows:—**Mr. E. T. Muston** to be general superintendent at Rugby; **Mr. D. Edmundson** to be manufacturing manager, AEI Electronic Apparatus Division; and **Mr. G. P. Thompson** to be manager at Rugby works.

It has been announced by R. and J. Beck Limited, one of the Griffin and George group of companies, that **Mr. J. W. Haig-Ferguson,** M.A., A.M.I.Mech.E., A.M.I.E.E., has been appointed managing director of the company.

New chairmen of two B.S.I. Industry Standards Committees have been announced by the British Standards Institution. **Sir Ben Lockspeiser,** director and scientific adviser of Tube Investments Limited and of Staveley Coal and Iron Limited, and also a director of Fulmer Research Institute Limited, is chairman of the Nuclear Energy Standards Committee. **Sir Anthony Bowlby,** a director of Guest, Keen and Nettlefolds Limited and chairman of Ionic Plating Company Limited, is chairman of the Surface Coatings, other than paints, Standards Committee.

Metal Market News

ZINC has been a good deal in the Metal Exchange picture of late, for the price has advanced in an almost spectacular fashion, mainly, it would seem, on expectations of some decision to deal with the problem of over-supply being reached at the international conference next March. The excess of zinc is almost entirely in the United States, for in the U.K. at any rate, the situation operates rather on a hand to mouth basis. This, it should be emphasized, relates to the high grade quality, which is the popular grade with alloy manufacturers. Nevertheless, stocks, according to the British Bureau of Non-Ferrous Metal Statistics, went up at the year end to 59,397 tons from 52,659 tons at November 30. Consumption was down in December to 28,481 tons, a fall of about 4,100 tons. The Copper Institute figures for January were published last week and reveal, it must be said, a satisfactory state of affairs in spite of the talk about the excess of production over consumption. Details, in short tons of 2,000 lb., are as follows: Inside the United States, production of crude copper was 108,515 tons, against 111,777 tons in December, while the output of refined was 144,697 tons, compared with 152,211 tons in the previous month. Deliveries were 8,631 tons up at 99,794 tons, while stocks of refined metal in producers' hands advanced by less than 5,000 tons to 144,132 tons. Outside the U.S.A., output of crude copper was 5,200 tons down at 200,547 tons, while in refined production there was an increase of about 10,300 tons to 176,851 tons. Deliveries were again surprisingly high at 214,645 tons, only about 11,000 tons lower than December and a long way above the 1960 average. Stocks, at 292,757 tons, were about 4,200 tons higher.

The outstanding feature of these figures is, of course, the remarkable volume of deliveries for the second month running in countries outside the United States. The explanation must almost certainly be efforts by consumers to build up their position in case of a stop on supplies from Chile or the Congo. While activity in those plants manufacturing semis is quite good, it is not better than it was in the autumn, and deliveries are certainly higher now than they were then. Metal Exchange stocks were rather heavily drawn upon, and at the end of last week the total was reported down by 645 tons to 14,975 tons. The market responded to this and got off to a good start on Monday at around £223, the peak for the week being reached on Thursday, at £225 for cash and £225 10s. 0d. for three months. Finally, the close was £224 cash and £224 10s. 0d. three months, which showed a gain of £3 5s. 0d. prompt and £1 15s. 0d. forward. The contango narrowed from £2 to 10s. Some 13,650 tons changed hands. On Friday last, the Belgian price advanced to 31 francs per kilo.

Tin put up a good show last week, for, on a turnover of about 600 tons, cash gained £7 to £794 10s. 0d., while three months advanced by £6 10s. 0d. to £797. Warehouse stocks were reduced by 42 tons to 10,098 tons. Better consumer participation and more cheerful news about the outlook for the metal were responsible for the rise in value. Stocks of zinc in Metal Exchange warehouses dropped by 135 tons to 3,505 tons, and there was news from the States that a prominent producer was cutting by 15 per cent, equal to 2,000 tons monthly. The turnover was 11,225 tons, cash closing £1 up at £84, and three months £1 12s. 6d. up at £83 7s. 6d. The turnover was 11,225 tons. Lead stocks were down 87 tons to 11,155 tons and the market was firm, cash closing £2 up at £67, and three months £1 12s. 6d. better at £67 12s. 6d.

Birmingham

Although motor manufacturers are very cautious about recent developments in the trade, the position has improved with the restoration of the full five-day week at one of the biggest concerns. Another shift has been added at an equally important factory, but in this instance it is pointed out that about 40,000 of the total labour force of about 60,000 are still on less than a five-day week. Another encouraging sign is more activity amongst makers of components. Indeed, one firm is working overtime on a valuable export order recently secured. It can be said that expansion has come earlier than most people expected, even though it is modest as yet.

Steel activity is well maintained at Midland works and mills, and there has been an increase in the tonnage of steel sheet supplied to the motor trade. There is a strong demand for raw material from the makers of agricultural tractors. The market for structural steel is such that makers of joists and sections, and other building material, are assured of work for the present quarter, but in some instances new orders are coming in only slowly. The foundry trade is well supported by the demand for castings from the engineering industries.

New York

Copper futures, after early steadiness, firmed on week-end covering on moderate dealings. Custom smelters and producers indicated continued fair sales, while dealers noted quiet conditions. Dealers were offering domestic copper near the 29 cents level of producers and custom smelters, and consumers are more willing to buy from their regular suppliers, the producers and custom smelters. Sales are generally for nearbys, February and some March. Tin was firmer but quiet, aided by the advance in Singapore. Lead and zinc were slightly active. Tin was softer and quiet in late dealings. Scrap copper was unchanged.

The St. Joseph Lead Company has announced that, effective immediately, it is curtailing the production of refined zinc metal by 15 per cent at its Josephtown, Pennsylvania, zinc smelter. The company also said it is deferring to a later date its planned expansion of its lead smelter at Herculaneum, from 110,000 tons a year, its present capacity, to 150,000 tons annually. A spokesman said the action was made necessary by present economic conditions and the over-supply of both lead and zinc in the U.S. market. The reduction at the St. Joseph Lead Company's Josephtown, Pennsylvania, zinc smelter, will cut about 1,650 tons of zinc metal a month, since output had been running at a monthly rate of nearly 11,000 tons of refined zinc.

Paris

It is learned that talks are going on between Pechiney and the Kaiser Aluminum Company. The project under discussion is a jointly financed and run aluminium plant with a 25,000 tons production in the Argentine. The new plant would come under the Argentine's economic development plan. Pechiney is also collaborating with Portugal and talks are going on for the construction of an aluminium plant in Doudo in the Portuguese possession of Angola. The region is rich in bauxite and the Cambambe dam, which is nearing completion, will have a capacity of 1,300,000,000 kWh.

The new plant should be ready to start operating in 1962, and will have a 25,000 tons capacity, which will be doubled later.

The Ugine Company reports that in 1960 aluminium production reached 47,900 tons against only 28,466 tons the previous year. This increase is due to the new plant at Lannemezan coming into operation.

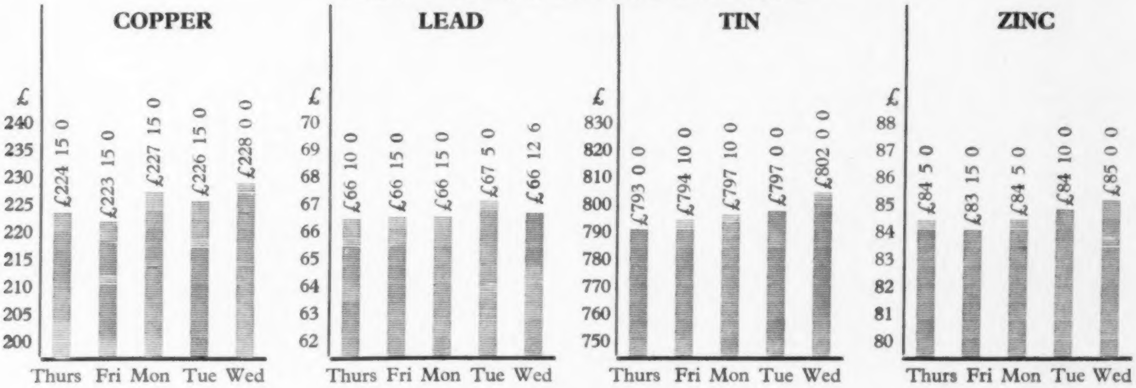
A pilot plant for the production of aluminium by a new carbo-thermic aluminium oxide method is now being built by Pechiney-Ugine. The method has been at the laboratory stage for many years. The pilot plant will have a capacity of between 3,000 and 5,000 tons per year.

In 1960, France produced 235,000 tons of aluminium, against 173,000 tons in 1959. Pechiney was responsible for 187,300 tons, against 144,530 tons.

Non-Ferrous Metal Prices

London Metal Exchange

Thursday 16 February to Wednesday 22 February 1961



Primary Metals

All prices quoted are those available at 2 p.m. 22/2/61

		£	s.	d.
Aluminium Ingots	ton	186	0	0
Antimony 99·6%	,,	217	10	0
Antimony Metal 99%..	,,	210	0	0
Antimony Oxide Commercial	,,	194	10	0
Antimony White Oxide	,,	196	0	0
Arsenic	,,	400	0	0
Bismuth 99·95%......	lb.		16	0
Cadmium 99·9%	,,		11	0
Calcium	,,	2	0	0
Cerium 99%	,,	15	0	0
Chromium	,,		6	11
Cobalt	,,		12	0
Columbite .... per unit		8	15	0
Copper H.C. Electro..	ton	228	0	0
Fire Refined 99·70%	,,	227	0	0
Fire Refined 99·50%	,,	220	0	0

		£	s.	d.
Copper Sulphate	ton	76	0	0
Germanium	grm.		—	
Gold	oz.	12	11	0
Indium	,,		10	0
Iridium	,,	24	0	0
Lanthanum	grm.		15	0
Lead English..........	ton	66	12	6
Magnesium Ingots	lb.			
99·8%	,,		2	2½
99·9+%	,,		2	3
Notched Bar	,,		2	9½
Powder Grade 4......	,,		6	1
Alloy Ingot, AZ91X..		1	11¾-2	1¼
Manganese Metal	ton	280	0	0
Mercury	flask	69	0	0
Molybdenum	lb.	1	10	0
Nickel	ton	600	0	0
F. Shot	lb.		5	5
F. Ingot	,,		5	6
Osmium	oz.	20	0	0
Osmiridium	,,		—	

		£	s.	d.
Palladium	oz.	9	0	0
Platinum	,,	30	5	0
Rhodium	,,	46	0	0
Ruthenium	,,	16	0	0
Selenium	lb.	2	6	6
Silicon 98%	ton	122	0	0
Silver Spot Bars	oz.		6	7⅝
Tellurium Sticks	lb.	2	0	0
Tin	ton	802	0	0
***Zinc**				
Electrolytic	ton		—	
Min 99·99%	,,		—	
Virgin Min 98%	,,	84	5	7½
Dust 95/97%	,,	125	0	0
Dust 98/99%	,,	131	0	0
Granulated 99+% ..	,,	109	5	7½
Granulated 99·99+%	,,	124	17	6

**Duty and Carriage to customers' works for buyers' account.*

Foreign Quotations

Latest available quotations for non-ferrous metals with approximate sterling equivalents based on current exchange rates

	Belgium fr/kg≏£/ton		Canada c/lb≏£/ton		France fr/kg≏£/ton		Italy lire/kg≏£/ton		Switzerland fr/kg≏£/ton		United States c/lb≏£/ton	
Aluminium			26.00	215 16	2.43	179 11	370	216 1	2.50	206 5	26.00	207 4
Antimony 99.0					2.30	170 0	495	286 3			29.00	231 2
Cadmium					15.75	1,069 0					150.00	1,195 10
Copper												
Crude												
Wire bars 99.9							420	245 5				
Electrolytic	30.25	223 11	27.50	222 15	3.05	225 7			2.83	231 0	29.00	231 6
Lead			10.00	81 0	.94	69 9	163	95 3	.83	68 9	11.00	87 13
Magnesium												
Nickel			70.00	581 0	9.00	665 2	1,200	699 6	7.50	618 15	74.00	589 15
Tin	109.50	800 6			11.15	823 19	1,480	874 6	9.58	805 12	100.37	799 18
Zinc												
Prime western			12.00	99 12 0								
High grade 99.95			12.60	104 11 0								
High grade 99.99			13.00	107 18 0					1.10	92 10		
Thermic					1.20	88 13						
Electrolytic					1.28	94 13	181	105 14			13.00	104 0

Non-Ferrous Metal Prices (continued)

Ingot Metals

All prices quoted are those available at 2 p.m. 22/2/61

Aluminium Alloy (Virgin)

		£	s.	d.
B.S. 1490 L.M.5	ton	210	0	0
B.S. 1490 L.M.6	„	202	0	0
B.S. 1490 L.M.7	„	216	0	0
B.S. 1490 L.M.8	„	203	0	0
B.S. 1490 L.M.9	„	203	0	0
B.S. 1490 L.M.10....	„	221	0	0
B.S. 1490 L.M.11....	„	215	0	0
B.S. 1490 L.M.12....	„	223	0	0
B.S. 1490 L.M.13....	„	216	0	0
B.S. 1490 L.M.14....	„	224	0	0
B.S. 1490 L.M.15....	„	210	0	0
B.S. 1490 L.M.16....	„	206	0	0
B.S. 1490 L.M.18....	„	203	0	0
B.S. 1490 L.M.22....	„	210	0	0

Aluminium Alloys (Secondary)

		£	s.	d.
B.S. 1490 L.M.1	ton	171	0	0
B.S. 1490 L.M.2	„	174	0	0
B.S. 1490 L.M.4	„	183	0	0
B.S. 1490 L.M.6	„	183	0	0

***Aluminium Bronze**

		£	s.	d.
BSS 1400 AB.1......	ton	245	0	0
BSS 1400 AB.2......	„	253	0	0

***Brass**

		£	s.	d.
BSS 1400-B3 65/35 ..	ton	176	0	0
BSS 249	„	—		
BSS 1400-B6 85/15 ..	„	224	0	0

***Gunmetal**

		£	s.	d.
R.C.H. 3/4% ton	„	—		
(85/5/5/5) LG2	„	220	0	0
(86/7/5/2) LG3	„	230	0	0
(88/10/2/1)	„	282	0	0
(88/10/2/½)	„	293	0	0

***Manganese Bronze**

		£	s.	d.
BSS 1400 HTB1.....	„	196	0	0
BSS 1400 HTB2.....	„	213	0	0
BSS 1400 HTB3.....	„	231	0	0

Nickel Silver

		£	s.	d.
Casting Quality 12%	„	235	0	0
„ „ 16%	„	250	0	0
„ „ 18%	„	290	0	0

***Phosphor Bronze**

		£	s.	d.
B.S.1400P.B.1.(A.I.D. released)	„	310	0	0
B.S. 1400 L.P.B.1	„	242	0	0

**Average prices for the last week-end.*

Phosphor Copper

		£	s.	d.
10%	ton	252	0	0
15%	„	255	0	0

Phosphor Tin

		£	s.	d.
5%	„	871	0	0

Silicon Bronze

		£	s.	d.
BSS 1400-SB1	„	275	0	0

Solder, soft, BSS 219

		£	s.	d.
Grade C Tinmans ...	„	368	0	0
Grade D Plumbers ..	„	294	0	0
Grade M	„	403	10	0

Solder, Brazing, BSS 1845

		£	s.	d.
Type 8 (Granulated)	lb.	—		
Type 9 „	„	—		

Zinc Alloys

		£	s.	d.
BSS 1004 Alloy A ..	ton	118	7	6
BSS 1004 Alloy B....	„	122	7	6
Sodium-Zinc	lb.		2	7

Semi-Fabricated Products

Prices vary according to dimensions and quantities. The following are the basis prices for certain specific products.

Aluminium

Sheet 10 S.W.G.	lb.		2	10½
Sheet 18 S.W.G.	„		3	0½
Sheet 24 S.W.G.	„		3	3½
Strip 10 S.W.G.	„		2	10½
Strip 18 S.W.G.	„		2	11½
Strip 24 S.W.G.	„		3	1
Circles 22 S.W.G.	„		3	4½
Circles 18 S.W.G.	„		3	3½
Circles 12 S.W.G.	„		3	2½
Plate as rolled	„		2	10
Sections	„		3	4
Wire 10 S.W.G.	„		3	1½
Tubes 1 in o.d. 16 S.W.G.	„		4	4

Aluminium Alloys

BS1470. HS19W.			
Sheet 10 S.W.G.	„	3	3
Sheet 18 S.W.G.	„	3	5½
Sheet 24 S.W.G.	„	4	1
Strip 10 S.W.G.	„	3	3
Strip 18 S.W.G.	„	3	4½
Strip 24 S.W.G.	„	4	0½
BS1477. HP30M.			
Plate as rolled	„	3	1
BS1470. HC15WP.			
Sheet 10 S.W.G.	„	4	3
Sheet 18 S.W.G.	„	4	8½
Sheet 24 S.W.G.	„	5	8½
Strip 10 S.W.G.	„	4	4
Strip 18 S.W.G.	„	4	8½
Strip 24 S.W.G.	„	5	4½
BS1477. HPC15WP.			
Plate heat treated ...	„	3	10½
BS1475. HG19W.			
Wire 10 S.W.G.	„	4	2
BS1471. HT19WP.			
Tubes 1 in. o.d. 16 S.W.G.	„	5	5
BS1476. HE19WP.			
Sections	„	3	4
Split tube			
19 S.W.G. (½")	„	4	2
20 S.W.G. (⅝")	„	3	11
21 S.W.G. (⅜")	„	4	1
22 S.W.G. (¼")	„	4	11
Welded tube			
14 to 20 S.W.G. (sizes ⅜" to 1½")	„	3/10½ to 5/8½	

Brass

Tubes	lb.		1	9⅝
Brazed Tubes	„		3	2½
Drawn Strip Sections	„		3	2
Sheet	ton	197	0	0
Strip	„	197	0	0
Extruded Bar	lb.		2	0½
Condenser Plate (Yellow Metal).............	ton	185	0	0
Condenser Plate (Naval Brass).............	„	196	0	0
Wire	lb.		2	8½

Beryllium Copper

Strip	„	1	4	11
Rod	„	1	1	6
Wire	„	1	4	9

Copper

Tubes	lb.		2	1⅞
Sheet	ton	258	10	0
Strip	„	258	10	0
H.C. Wire	„	275	15	0

Cupro Nickel

Tubes 70/30	lb.		3	5⅞

Lead

Pipes (London)	ton	107	0	0
Sheet (London)	„	104	15	0
Tellurium Lead	„	£6 extra		

Nickel Silver

Sheet and Strip 10%..	lb.	3	9¾
Wire 10%	„	4	2¾

Phosphor Bronze

Wire	„	4	0¾

Titanium (1,000 lb. lots)

Billet 4½" to 18" dia.....	lb.	47/-	48/-
Rod ¼" to 4" dia........	„	85/-	53/-
Wire ·036"-232" dia....	„	159/-	99/-
Strip ·001" to ·048"....	„	350/-	68/-
Sheet 8'×2'. 20 gauge	„	73/-	
Tube, representative average gauge	„	198/-	
Extrusions	„	90/-	

Zinc

Sheet	ton	122	15	0
Strip	„	nom.		

Domestic and Foreign

Merchants' average buying prices delivered, per ton, 21/2/61.

Aluminium

	£
New Cuttings	139
Old Rolled	113
Segregated Turnings	74

Brass

Cuttings	160
Rod Ends	144
Heavy Yellow	135
Light	129
Rolled	148
Collected Scrap	134
Turnings	137

Copper

Wire	206
Firebox, cut up	203
Heavy	201
Light	198
Cuttings	208
Turnings	185
Braziery	179

Gunmetal

	£
Gear Wheels	195
Admiralty..................	195
Commercial	182
Turnings	177

Lead

Scrap	57

Nickel

Cuttings	—
Anodes	540

Phosphor Bronze

Scrap	182
Turnings	177

Zinc

Remelted	73
Cuttings	61
Old Zinc	42

Financial News

Metal Industries Ltd.

This company is extending its activities in Australia by the acquisition of the whole of the share capital of a New South Wales electrical engineering group, Alcol Holdings Pty. Ltd. This latter company owns the whole of the share capital of Alan Colless Pty. Limited and Designed Control and Manufacturing Pty. Limited. All three companies operate from a factory at Silverdale, near Sydney.

The main business of Alan Colless Pty. Limited is the sale throughout Australia of the products of Brookhirst Igranic Limited, M.I.'s major electrical engineering subsidiary. The principal business of Designed Control and Manufacturing Pty. Limited is the manufacture of control gear based on components manufactured in England by Brookhirst Igranic Limited and imported into Australia by Alan Colless Pty. Limited. Alcol Holdings Pty. Limited does not engage in commercial or industrial activities.

Vulcan Foundry

Controlled by English Electric Company, group profit of this company is shown at £574,209 (£435,784), after depreciation £148,661 (£160,068). To subvention payments £475,000 (nil), tax £34,500 (£211,000), general reserve—tax relief on the excess of capital allowances over depreciation — £11,000 (£49,000). Group net balance £53,709 (£175,784). Dividend on Ordinary at 5 per cent.

Australian Aluminium

It was announced in Melbourne last week that agreement has been reached with Metal Manufactures Limited for the purchase by Comalco Aluminium Products of the aluminium fabricating facilities of Austral Bronze Company Pty. Limited in New South Wales and Victoria. The latter is a wholly-owned subsidiary of Metal Manufactures, and Comalco Aluminium Products is the fabricating subsidiary of the Consolidated Zinc-Kaiser Aluminum partnership. It was recently incorporated in Victoria with a nominal capital of £A10,000,000.

As a result of these negotiations, Comalco Aluminium Products will take over the Cumberland brass and aluminium mills of Austral Bronze at Yennora, near Sydney. It will also purchase the aluminium extrusion press and certain other facilities of Austral Bronze at Maribyrnong, in Victoria. Brass strip facilities at Yennora are excluded from the purchase and will be moved by Austral Bronze to another site at a mutually convenient time.

It is understood that Comalco Aluminium Products will immediately take over the existing aluminium extrusion business of Austral Bronze and complete the present programme for the production of aluminium sheet at Yennora which is scheduled for October of this year. The Yennora programme will be supplemented by the addition within two years of a hot breaking down mill and a foil rolling plant. The total programme will approximate £A7,000,000.

National Lead Company

It is reported from New York that net income of the company dropped 4 per cent to an estimated $50,200,000, or $4·10 a share, last year from $52,500,000 or $4·30 a share in 1959. Sales slipped 1·5 per cent to $522,700,000 from $530,600,000.

Mr. Joseph Martino, the President, said sales and earning of the company's foreign operations reached record levels in 1960. Sales of paints, refractories, precision bearings and die-castings increased from a year earlier, he added.

The Thermal Syndicate

Group net profit increased to £228,004 (£180,378) for the year ended October 31, 1960. It is reported that the dividend will be raised to 20 per cent from 15 per cent.

Westinghouse Brake and Signal

At the annual meeting of the company in London this week, the chairman, Captain A. R. S. Nutting, stated that it was proposed to introduce the practice of paying an interim dividend, and that any such interim proposed would be declared in July and paid in September.

Scrap Metal Prices

The figures in brackets give the English equivalents in £1 per ton:—

France (new francs per kilo):

Electrolytic copper scrap	(£218.0.0)	2.95
Heavy copper	(£218.0.0)	2.95
No. 1 copper wire	(£210.12.0)	2.85
Brass rod ends	(£162.11.0)	2.20
Zinc castings	(£65.0.0)	0.88
Lead	(£64.5.0)	0.87
Aluminium	(£134.9.0)	1.82

Italy (lire per kilo):

Aluminium soft sheet clippings (new)	(£178.2.0)	305
Lead, soft, first quality	(£79.8.0)	136
Lead, battery plates	(£43.16.0)	75
Copper, first grade	(£207.6.0)	355
Bronze, commercial gunmetal	(£169.1.0)	290
Brass, heavy	(£140.3.0)	240
Brass, light	(£125.11.0)	215
Brass, bar turnings	(£143.1.0)	245
Old zinc	(£57.4.0)	98

Japan (Yen per metric ton):

Electrolytic copper	(£—)	273,000
Copper wire No. 1	(£—)	253,000
Copper wire No. 2	(£—)	234,000
Heavy copper	(£—)	243,000
Light copper	(£—)	203,000
Brass, new cuttings	(£—)	185,000
Red brass scrap	(£—)	212,000

West Germany (D-marks per 100 kilos):

Used copper wire	(£195.1.0)	225
Heavy copper	(£190.14.0)	220
Light copper	(£173.8.0)	200
Heavy brass	(£125.14.0)	145
Light brass	(£86.14.0)	105
Soft lead scrap	(£50.5.0)	58
Zinc scrap	(£47.13.0)	55
Used aluminium unsorted	(£78.1.0)	90

New Companies

The particulars of companies recently registered are quoted from the daily register compiled by Jordan and Sons Limited, Company Registration Agents, Chancery Lane, W.C.2.

Tespa Limited (681197), 27 Broomgrove Road, Sheffield, 10. Registered January 20, 1961. To carry on business of designers, manufacturers of and dealers in strapping and banding for industrial purposes in stainless steel, ferrous and non-ferrous metals and other suitable materials for hose couplings, etc. Nominal capital, £1,000 in £1 shares. Permanent directors: Gilbert E. Simm, Gilbert E. Simm, jnr., and John B. Simm.

Ralnor Limited (681345), 94 Baker Street, W.1. Registered January 23, 1961. To carry on the business of merchants of and dealers in metals, etc. Nominal capital, £100 in £1 shares. Director: Lewis A. L. Nestel, C.A.

John England (Tubes) Ltd. (681435), Hemfield Road, Ince, Wigan. Registered January 24, 1961. To carry on business of merchants and stockists of steel, iron and other ferrous and non-ferrous tubes, etc. Nominal capital, £100 in £1 shares.

Light Metal Statistics

Figures showing the U.K. production, etc., of light metals for Nov. 1960, have been issued by the Ministry of Supply as follows (in long tons):—

Virgin Aluminium	
Production	1,970
Imports	27,992
Despatches to consumers	32,590
Secondary Aluminium	
Production	10,307
Virgin content of above	1,073
Despatches (including virgin content)	10,481
Scrap	
Arisings	15,081
Estimated quantity of metal recoverable	10,543
Consumption by:	
(a) Secondary smelters	13,548
(b) Other uses	1,110
Despatches of wrought and cast products	
Sheet, strip and circles	13,990
Extrusions (excluding forging bar, wire-drawing rod and tube shell):	
(a) Bars and sections	4,322
(b) Tubes (i) extruded	383
(ii) cold drawn	678
(iii) formed strip	—
(c) (i) Wire	1,386
(ii) Hot rolled rod (not included in (c) (i)	83
Forgings	363
Castings: (a) Sand	1,810
(b) Gravity die	4,808
(c) Pressure die	2,130
Foil	2,194
Paste	301
Magnesium Fabrication	
Sheet and strip	17
Extrusions	147
Castings	216
Forgings	13

THE STOCK EXCHANGE

Industrial Equities Generally Fairly Well Supported

ISSUED CAPITAL ⊕	AMOUNT OF SHARE	NAME OF COMPANY	MIDDLE PRICE 20 FEBRUARY	+RISE—FALL	DIV. FOR LAST FIN. YEAR	DIV. FOR PREV. YEAR	DIV. YIELD	1960-61 HIGH	1960-61 LOW	1959 HIGH	1959 LOW
£	£				Per cent	Per cent					
4,435,792	1	Amalgamated Metal Corporation ...	29/-	—3d.	11	9	7 11 9	34/9	25/6	33/3	23/3
400,000	2/-	Anti-Attrition Metal	1/-		NIL	4	NIL	1/6	0/9	1/7½	1/-
41,303,829	Stk. (£1)	Associated Electrical Industries ...	40/9	—3d.	15	15	7 7 3	67/3	39/3	67/-	54/-
3,236,424	1	Birfield	51/6	—6d.	10	15‡	3 17 9	52/-	29/-	75/4½	46/-
4,795,000	1	Birmid Industries	76/-	+1/-	20	20D	5 5 3	76/-	56/-	75/6	46/9
5,630,344	Stk. (10/-)	Birmingham Small Arms	30/6	—6d.	17½QT	12½	3 16 6	32/-	18/4½	69/-	36/-
203,150	Stk. (£1)	Ditto Cum. A. Pref. 5%	14/6	—4½d.	5	5	6 18 0	17/4½	14/4½	17/6	15/-
350,580	Stk. (£1)	Ditto Cum. B. Pref. 6%	17/4½		6	6	6 17 3	20/-	17/1½	20/1½	17/9
500,000	1	Bolton (Thos.) & Sons	43/9	+9d.	10	10	4 11 6	43/9	37/-	47/-	27/6
300,000	1	Ditto Pref. 5%	14/-		5	5	7 2 9	16/-	13/6	16/-	14/9
1,500,000	Stk. (£1)	British Aluminium Co. Pref. 6% ...	17/-		6	6	7 1 3	21/1½	16/9	21/6	18/9
18,846,647	Stk. (£1)	British Insulated Callender's Cables	55/9	—9d.	13½	13½	4 16 9	61/-	47/6	61/-	45/1½
17,047,166	5/-	British Oxygen Co. Ltd., Ord. ...	30/9	+3/6	16	16	2 12 0	34/6	19/6	87/9	49/3
1,200,000	Stk. (5/-)	Canning (W.) & Co.	16/3	+2/-	15+8⅓C	25+ *2½C‡	4 12 3	19/6	13/3	18/1½	12/3
60,484	1/-	Carr (Chas.)	1/3	+1½d.	NIL	12½	—	2/3	1/-	2/10½	1/3
555,000	1	Clifford (Chas.) Ltd.	26/3		10	10	7 12 6	35/-	26/-	30/-	22/6
46,000	1	Ditto Cum. Pref. 6%	15/3		6	6	7 17 6	16/-	15/3	16/-	17/-
300,000	2/-	Coley Metals	4/-		15	15	7 10 0	5/-	3/3	4/6	2/6
10,185,696	1	Cons. Zinc Corp.†	69/9	—9d.	20	15	5 14 9	80/-	60/6	77/3	57/9
5,399,056	1	Davy-Ashmore	150/-	+2/6	30‡	20	1 19 9	150/3	100/6	116/-	43/-
7,695,000	5/-	Delta Metal	22/-	—4½d.	17½	31‡	3 19 9	28/-	18/7½	26/4½	11/6
5,296,550	Stk. (£1)	Enfield Rolling Mills Ltd.	45/9	—1/3	15	15	6 11 3	56/3	45/-	61/9	36/7½
1,155,000	1	Evered & Co.	44/-		10B	10ɸ	3 0 0	42/9	29/-	42/6	30/-
18,000,000	Stk. (£1)	General Electric Co.	31/-xd	—1½d.	10	10	6 9 0	51/6	29/3	50/6	30/-
1,500,000	Stk. (10/-)	General Refractories Ltd.	50/-	+1/3	20	20	4 0 0	51/6	40/-	47/-	31/4½
750,000	5/-	Glacier Metal Co. Ltd.	14/9		13	11¼	4 9 9	15/9	11/1½	11/3	6/7½
2,500,000	5/-	Glynwed Tubes	23/9	—3d.	25¶	20	3 13 0	27/1½	17/7½	30/9	16/1½
7,228,065	10/-	Goodlass Wall & Lead Industries ...	38/6	+1/-	19L	16	3 15 3	41/6	33/4½	53/-	28/7½
696,780	10/-	Greenwood & Batley	25/3xcap		30W	30	5 18 9	27/-	23/9Z	130/-	75/-
792,000	5/-	Harrison (B'ham) Ord.	12/4½		*20‡	*17½	4 0 9	15/4½	11/9	26/9	14/-
150,000	1	Ditto Cum. Pref. 7%	20/-		7	7	7 0 0	20/-	19/3	19/6	19/4½
1,075,167	5/-	Heenan Group	13/-	+9d.	13D	15	4 7 3P	13/-	10/-	19/6	7/4½
249,932,548	Stk. (£1)	Imperial Chemical Industries ...	70/3	+6d.	11¼N	8	3 2 0	75/3	54/-	62/7½	33/1½
34,736,773	Stk. (£1)	Ditto Cum. Pref. 5%	15/9		5	5	6 7 0	17/9	15/3	19/1½	15/6
22,184,044	**	International Nickel	118	+5½	$1.60	$1.50	2 11 0	117½	85½	201½	154½
300,000	1	Johnson, Matthey & Co. Cum. Pref. 5%	14/3		5	5	7 0 3	16/6	14/1½	17/6	14/9
6,000,000	1	Ditto Ord.	62/3	—3d.	12	12D	3 17 3	66/6	45/-	50/3	27/3
600,000	10/-	Keith, Blackman	20/3	+3d.	17½	17½E	8 12 9	32/6	17/9	32/-	25/-
320,000	4/-	London Aluminium	10/4½		12	10	4 12 6	12/6	7/6	10/7½	5/3
765,012	1	McKechnie Bros. Ord.	57/-		17½F	15F	6 2 9	71/6	57/-	62/6	39/9
1,830,024	1	Ditto A. Ord.	53/9		17½F	15F	6 10 3	69/3	55/-	65/6	38/9
1,108,268	5/-	Manganese Bronze & Brass	14/9	—3d.	20⅝	20⅝	6 16 9	18/9	13/4½	19/-	13/6
50,628	6/-	Ditto (7½% N.C. Pref.)	6/-		7½	7½	7 10 0	6/6	5/10½	7/9	5/9
21,745,110	Stk. (£1)	Metal Box	80/6	—1/-	12M	13B	2 14 6	84/9	55/9	80/-	44/7½
415,760	Stk. (2/-)	Metal Traders	7/3		50	50	13 15 9	10/4½	7/1½	13/6	8/4½
160,000	1	Mint (The) Birmingham	36/9		10	10	5 8 9	39/-	33/6	35/-	22/-
80,000	5	Ditto Pref. 6%	76/3		6	6	7 17 6	80/-	75/-	80/-	69/-
5,187,938	Stk. (£1)	Morgan Crucible A.	58/6	+1/-	13	12	4 9 0	62/3	47/6	52/6	30/-
1,000,000	Stk. (£1)	Ditto 5½% Cum. 1st Pref. ...	16/-		5½	5½	6 17 6	18/6	15/9	19/3	17/3
3,860,000	Stk. (£1)	Murex	41/3	—9d.	22½ J	15	6 9 0	45/-	35/3	76/4½	41/-
585 000	5/-	Ratcliffs (Great Bridge) Ord. ...	16/6		10	10R	3 1 6	17/-	14/9	—	
195 000	5/-	Ditto 8% Max. Ord.	5/-		8	—	8 0 0	5/3	5/-	—	
1,064,390	10/-	Sanderson Kayser	36/3	+1/3	35‡	25	4 16 6	40/3	27/7½	56/-	27/9
3,400,500	Stk. (5/-)	Serck	16/1½		12½	17½GD	3 17 0	25/-	15/3	26/-	12/-
7,232,069	Stk. (£1)	Stone-Platt Industries	62/3	—6d.	15	15	4 16 0	64/6	52/3	63/6	42/6
2,928,963	Stk. (£1)	Ditto 5½% Cum. Pref.	15/-		5½	5½	7 6 9	18/7½	15/-	18/9	15/10½
33,989,712	Stk. (£1)	Tube Investments Ord.	75/-	—1/6	14	20	3 14 9	95/9	66/3	138/-	71/7½
41,000,000	Stk. (£1)	Vickers	28/3	+3d.	10	10	7 1 6	39/-	27/3	40/6	26/10½
750,000	Stk. (£1)	Ditto Pref. 5%	13/-		5	5	7 13 9	17/6	14/-	17/3	14/3
6,863,807	Stk. (£1)	Ditto Pref. 5% tax free	19/9		*5	*5	7 10 6A	24/3	20/-	25/9	20/6
4,594,418	1	Ward (Thos. W.) Ord.	74/3	+4/3	13¾	25	3 13 6	86/-	64/-	167/6	83/-
7,109,424	Stk. (£1)	Westinghouse Brake	38/6	—6d.	11	10	5 14 3	59/9	36/6	60/7½	39/-
225,000	2/-	Wolverhampton Die-Casting ...	9/6		35	30	7 7 3	13/10½	8/3	13/1½	8/8½
591,000	5/-	Wolverhampton Metal	28/3	+9d.	32½	27½	5 15 0	39/6	23/9	34/3	21/6
156,930	2/6	Wright, Bindley & Gell	4/3	+3d.	15	20‡	8 16 6	4/3	2/10½	4/3	2/6
124,140	1	Ditto Cum. Pref. 6%	13/6		6	6	8 17 9	15/3	13/3	14/3	12/10½
150,000	1/-	Zinc Alloy Rust Proof	5/-	—1½d.	40	30	8 0 0	5/6	4/-	3/10½	2/9

*Dividend paid free of Income Tax. †Incorporating Zinc Corpn. & Imperial Smelting. **Shares of no Par Value. ‡ and 100% capitalized issue. ⊕The figures given relate to the issue quoted in the third column. A Calculated on £7 8 9 gross. D and 50% capitalized issue. C paid out of Capital Profits. E and 50% capitalized issue in 7% 2nd Pref. Shares. R and 33⅓% capitalized issue in 8% Maximum Ordinary 5/- Stock Units. ɸ and 6¼% from Capital Profits B and 50% capitalized issue. G and 1¾d. special distribution. F and special 5% tax free dividend. H As forecast. ¶And 3 for 7 capitalized issue. L and 33⅓% capitalized issue. M and 10% capitalized issue. N Interim since increased. J and 75% capitalized issue. S and 40% capitalized issue. O calculated at 13¾%. Interim on smaller capital. P Calculated at 11¼%. Q also 1/- special tax free dividend and 50% capitalized issue. T Per £1 unit. W Before capital reorganization. Calculated at 15%. Z After capital reorganization

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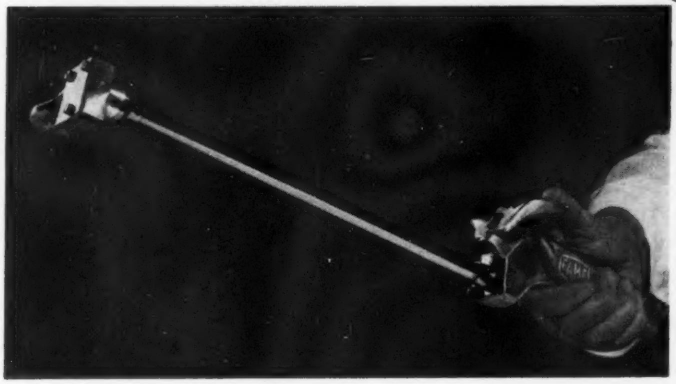

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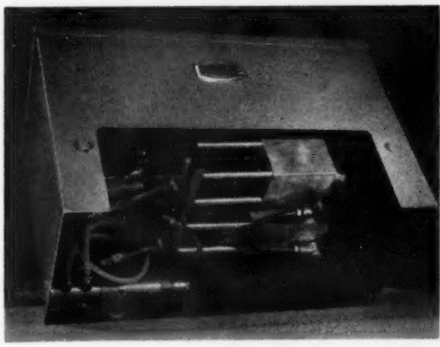

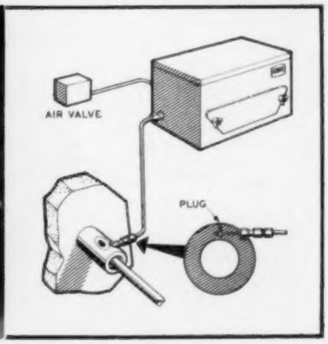

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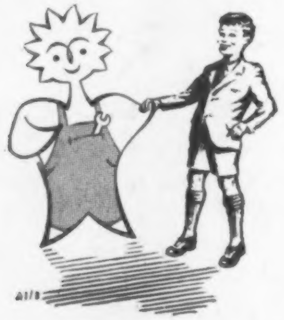

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